ON THE

MECHANICAL APPLIANCES

NECESSARY FOR

THE TREATMENT

OF

DEFORMITIES.

BY

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Quam quisque nôrit artem, in hâc se exerceat.

PART I.

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TO THE

MEDICAL PROFESSION OF GREAT BRITAIN,

AS A SLIGHT TESTIMONY OF GRATITUDE

FOR THE MANY AND GREAT FAVOURS

CONFERRED BY THEM UPON

THE AUTHOR.

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PREFACE.

THE reasons which prompted me to undertake the work of which this is the First Part will be found detailed at length in the Introduction; that they cannot be misinterpreted, I sincerely believe. I have endeavoured to give the contents in as clear and concise language as possible, knowing, that if they were clogged with a mathematical terminology and formulæ, they would, of necessity, be less generally intelligible; thus defeating the purpose for which my labours were commenced. A short description is given of each instrument, together with the theory of its action, and the manner in which it should be applied and adjusted, the whole being interwoven with such practical hints, as an experience of many years warrants me in supposing may be of some value, even to the accomplished surgeon.

In the Appendix, I have given such directions as will, I trust, enable Medical Men practising abroad, or in distant parts of this country, to take "plaster of Paris casts" of any deformity which they happen to be treating. By forwarding them to me, together with memoranda of the principal points worthy of remark, I could readily superintend the construction of whatever form of instrument may be necessary for the mechanical treatment of the case; and this, too, quite as well, *or nearly so*, as if Patient and Surgeon had put themselves to the trouble and expense of a journey to London.

Surgeons practising in India, or the Colonies, will probably be able, by the help of this book, to have whatever mechanisms they may require, constructed on the spot.

The Second Part, containing detailed notices of every approved variety of Spinal Apparatuses, will be shortly ready; and in order that I may carry out my ideas in a comprehensive and practically useful manner, I propose, should this *brochure* meet with a favourable reception, publishing a yearly Appendix, containing such new and really good appliances as may be invented by myself and others; hence, I trust that those Members of the Profession who are interested in the advance of this important branch of Science, will be enabled to keep up a constant acquaintance with the progress made in the construction of Orthopædic Mechanism.

HENRY HEATHER BIGG.

January, 1858.
29, *Leicester Square, London.*

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INTRODUCTION.

Although it is but just to assign due importance to the influence exerted by the discovery and practice of "Tenotomy," or, in other words, the subcutaneous division of the tendons of contracted muscles, as an agent in facilitating the successful treatment of deformities, still, it should ever be borne in mind, that very little practical benefit would have been derived from this valuable addition to surgical science, had not the instruments employed in effecting the *mechanical changes* in various distortions been constructed with a proportionate ratio of improvement. The earlier kinds of anatomical instruments used in the treatment of distortions were, for the most part, based upon a principle, "of compelling the deformed superficies of the part under treatment, to adapt itself to the shape of the instrument, which was constructed upon the *lines* of a well-shaped body;" instead of, as is the practice of the present day, "making the apparatus coincident in shape with the malformity, and then gradually reducing the limb to a natural form, by producing such changes in the mechanical bearings, as well as the external form of the instrument, as will bring the part into a correct position."

The following pages have been solely written with the view of placing a detailed description of such apparatuses as are peculiarly well calculated to effect the mechanical cure of the more ordinary forms of malformity at the disposal of the Medical Profession. Many of them are capable of being used in cases where tenotomy is unnecessary or undesirable; others are especially constructed for the purpose of elongating contracted muscles, after their tendons have been divided; almost all will be found valuable and necessary adjuncts to the treatment of some one or another of the multitudinous distortions which pass beneath the eye of most surgeons.

Writers on "Orthopædy" usually assert, that little or no progress was effected in the treatment of deformities for many years previous to the introduction of tenotomy; and add, that this quiescent state of the science was mainly referable to the fact of such cases having been left exclusively in the hands of surgical mechanists. Here they have fallen into a grave error, since the leading surgeons of the period referred to, used always, when treating these cases, to rely for success upon the mechanical skill and knowledge of the mechanist, *combined with and directed by their own opinions concerning the anatomical and surgical desiderata of each case.* Sir Astley Cooper, Messrs. Liston, Aston Key, and many others of the great ones who have passed from amongst us, may be cited as having been in the habit of personally witnessing the adaptation of such scientific appliances as were constructed in their day; with, as the author can prove by many memoranda which are in his possession, highly constant and satisfactory results. The mechanical details, however, they left to the mechanist—and very properly. The failures which occasionally occurred (are the practitioners of the present day *always* successful?), should not be attributed to the assumed fact, "that surgeons gave no attention to deformities;" but to a far more valid one, viz., that, in the absence of tenotomy, multitudes of cases were treated by mechanical means alone which were far too severe to be amenable to such and such only. Although it cannot be denied that the invention of the majority of the numerous mechanical appliances mentioned in this work, must be ascribed to the fact that the introduction of tenotomy placed the treatment of distortions more immediately within the power of modern surgery; still it must be universally conceded, that severe distortions would never be overcome, even after the performance of tenotomy, unless they were subjected to the continued mechanical action of scientific and carefully constructed instruments.

In my descriptions of various appliances, and their uses, I have found it impossible to avoid making an occasional reference to those anatomical points connected with the mechanical functions of the part that happened to be under consideration, as otherwise my meaning must have been obscured; but this has only been done to such an extent as is sufficient for the proper explanation of the theory of the mechanical construction and application of the several apparatuses, and certainly without the least desire of trenching upon the province of the surgeon.

No work has, up to the present time, been published in the English language, which can be said to treat exclusively upon the mechanisms employed in curing distortions;—for each Orthopædic author has given a description of the particular instruments which he himself affects and recommends, but not one has attempted to arrange, classify, and illustrate any variety of the kinds employed, for one and the same malformity, by different surgeons. A moment's reflection will show that this could not be well accomplished, save by a mechanist in large practice and daily communication with different eminent surgeons. I therefore penned the following pages, in the hope that I might have the great honour of filling up this palpable void in medical literature; and can only crave the indulgence of my readers, if the performance falls short of the desire which prompted the undertaking. I also imagined that, perhaps, a work of this kind might be of use to surgeons practising abroad, or in distant places.

A distortion, whether congenital or not, is *now*, for the most part, easily and rapidly removed; surgeons no longer having any reason to dread the application of mechanical contrivances "lest the patient should suffer in health!!" With improved scientific resources, infinitely greater successes have been obtained, and the consequent increase of practice in this department of surgery imperatively demands, that the construction of the manifold contrivances required for the reduction of these malformities, should be entrusted to individuals of far higher scientific attainments than the majority of the anatomical instrument-makers have hitherto possessed. To devise such appliances with a due regard to the exigencies of each individual case, is a matter of no ordinary importance and difficulty. Not only should the mechanist be familiarly acquainted, both theoretically and practically, with the sciences of "Applied Mechanics," and "Mathematical Induction," but he should likewise be tolerably well versed in the osteology and myology of the human body; he should possess an intimate knowledge of the anatomical, as well as of the superficial and external characteristics of the various malformations and distortions to which the frame of man is liable; he should be well read in those standard works which specially treat upon these subjects; he should possess the power of readily seizing upon, and scientifically eliminating and putting into shape whatever plans the surgeon may wish to see carried out in particular cases. In short, he should be well educated, and possessed of at least average ability.

Unless he is able to entrust his ideas to some one thus qualified, the surgeon cannot reckon with any confidence upon having that mechanical co-operation, apart from which his treatment cannot be prosecuted to a successful issue. He will be continually harassed and worried by finding that the appliances, when put into action, fail to fulfil some great though unusual requisition. In all probability, he will be unable to discover where the error exists for some time, and alteration after alteration will be made, to little or no purpose. It is highly desirable in most cases that the surgeon should personally demonstrate those anatomical points to the orthopædic mechanist, to which he thinks it desirable that special attention should be directed. Many mistakes and much trouble and expense would be avoided, if this course were always adopted; moreover, such a proceeding is highly advantageous to all parties; to the *surgeon*, because he obtains suggestions as to the practical details connected with the purely mechanical requisites, and likewise satisfies himself that the objects in view are thoroughly understood and appreciated; to the *mechanist*, for he is able to seek and obtain information on any anatomical or surgical point connected with the case, concerning which he may be doubtful or ignorant; to the *patient*, because his recovery is less likely to be retarded by blunders in the philosophic construction of the required apparatus.

But it is very different, as regards the ordinary run of "instrument makers." In their case, orthopædic science too frequently becomes degraded into a mere matter of manipulative skill. It is true that one workman may be better than another, but this is simply the result of practice, grafted upon a more delicate tactile sense than is possessed by the majority of his fellows. Here, science lies dormant, the whole affair is mechanical, *and mechanical only.* There is a total absence of the two great postulates of all real science—knowledge and thought.

From this it will be seen how impossible it is for the orthopædic mechanist (who does his duty) to delegate to others a supervision of the various appliances which may be required of him; at almost every stage, it is necessary that he should personally inspect the progress of his workmen, and witness the development of the ideas which are entrusted to him for execution.

Another salient point connected with his peculiar profession is, that as the knowledge of mechanical science increases, so is he enabled to simplify, and thereby to add, to the utility of the apparatuses that may be required of him, at the same time diminishing their cost. Thus, I have been enabled, in spinal appliances especially, to dispense with many complicated methods of obtaining mechanical power, frequently substituting curves of various arcs for the rack-and-pinion previously employed; and I have generally found that the lightness of the appliances has been much increased, without any diminution of their efficiency. The properties of curves, and their peculiar applicability to the construction of scientific apparatuses, are as yet but little understood. Little fault, however, can be found with the progress of orthopædic mechanics. Latterly it has been truly marvellous. I trust that I may not be misunderstood when I affirm, that the combination of the surgeon's scientific acquirements with those of the mechanist, affords the readiest, indeed the only proper method by which all cases of malformity can be treated with the certainty of a successful issue. I feel sure that an existence of the two offices in one and the same person would be practically impossible.

The discoveries of Delpech, Stromeyer, &c., and the consequent introduction of tenotomy, having largely contributed to the establishment of a more scientific treatment of deformities, every surgeon *now* has it in his power to adopt one or more of the numerous apparatuses described in the course of this book. Much care therefore has been taken to ensure the favourable mention of none which have not been applied by myself, and I am thus enabled to express a fair opinion as regards the merits, mechanical, scientific, and practical, of each and all of them.

When I commenced my labours, I did so with a full knowledge of their importance, as regards my own future career and reputation. I was well aware that my position would be greatly perilled by any misapprehension which might be excited in the medical world concerning my motives for endeavouring to place a detailed description of the most approved orthopædic appliances at their disposal: some might imagine that I wished to interfere with the position which is filled by those medical men who have especially studied this department of surgery; others, that I impertinently obtruded my personal opinions upon the profession at large. Nevertheless, when I reflected on the advantages which would be derived on all sides by a more generally diffused information concerning the subject upon which the work professes to treat, I felt that none but the malevolent could affect to mistake my motives, and that I should in all probability gain the good will of those whose approbation I most covet.

Should this little *brochure* be as kindly received by the medical profession as was my former work on "Artificial Limbs," I shall record in subsequent editions the progress made, from time to time, in the construction of surgical apparatuses, thus keeping the subject perfectly *au courant* with the advance of science.

ON DEFORMITIES,

ETC.

CHAPTER I.

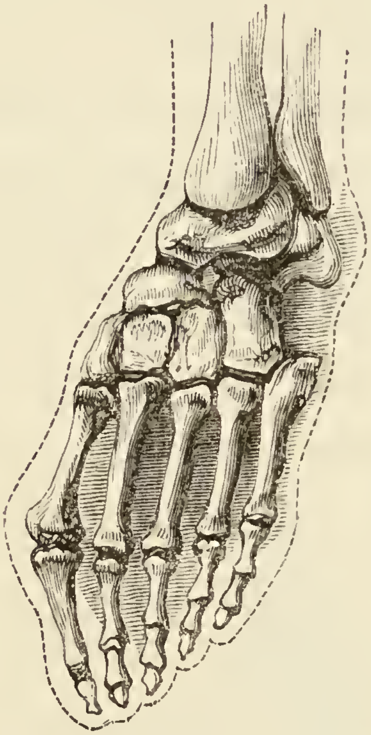
DEFORMITIES OF THE TOES.

Deformities incidental to, and affecting, the shape or proper action of the toes, are of such frequent occurrence, that they merit a far greater share of mechanical attention than has hitherto been bestowed upon them. Every one knows how much annoyance and pain is experienced by those who have the misfortune to be afflicted by that very common and unsightly malady, a bunion; yet few have cared to ascertain the primary causes which lead to this painful malformation of the toe-joint, and the means by which it may be most readily removed and cured. The toes, which form the anterior third of the human foot, are so articulated or joined together as to permit a limited amount of motion in almost every direction; *e.g.*, they can be uplifted, depressed, or moved laterally. This mobility of the "phalangeal joints" is due to the peculiar manner in which they are articulated; the opposing surfaces of each bone being crusted with a smooth cartilage, so arranged as to facilitate the gliding movement of bone upon bone in every direction, the joint being closed in and completed by strong ligaments above, below, and laterally, these ligaments not only holding the bones together, but checking and restraining the amount of motion within proper limits. Every joint, too, is separate, being a perfect shut sac, lined with a peculiar membrane called the "synovial membrane," which secretes a kind of fluid *joint-grease* termed "synovia." The advantage in this arrangement of connecting media is, that it allows of a considerable range for motion, imparting at the same time such an amount of horizontal strength as to render dislocation or disjunction of the bones almost impossible, save by the employment of extraordinary violence. That, however, which is so difficult of accomplishment by sudden and violent actual force, is partially brought about during the formation of a bunion, by the slow yet sure influence of a power acting for a considerable period in a direction opposed to the horizontal resistance of the ligaments which connect the internal anterior margin of the first metatarsal bone with the internal posterior margin of the first phalanx of the great-toe—or what is commonly called "the joint of the great-toe." A bunion may therefore be described as a widening of the metatarso-phalangeal joint of the great-toe at its internal lateral margin. When this occurs, the longitudinal axis of the great-toe, in the normal state coincident with that of the first metatarsal, is not only diverted from its original direction, taking an unnatural one outwards, but a gap is created within the joint between the internal osseous surfaces of the two bones, leading to an abnormal development of the integuments which cover the joint laterally, and the ultimate establishment of an unsightly callosity, painfully sensitive to pressure.

The proximate mechanical cause of bunion may most frequently be traced to an absurd habit of having boots made so narrow across the toe-joints as to necessitate the cramping of this part of the foot within a space far too confined for the preservation of a normal integrity of action in the long axis of the foot: the result of course being constant lateral pressure on the toes.

When this enlargement of the toe-joint assumes such proportions as to attract attention, the mechanical plan of treatment usually adopted is simply the employment of a thick piece of leather, having a hole in the centre, which is attached to the periphery of the enlargement; under the impression, of course, that it will receive the pressure tending to enlarge the joint, thus preventing its future increase. The least reflection will show how mischievous such a treatment must be; since, as the leather disc impinges upon the greater portion of the first phalanx of the toe, and the end of the metatarsal, whilst an open space is left at the joint itself, all force exercised by the boot *must* increase the malady, by tending to widen the distance between the already divided lateral margins of the joints. The idea of employing this disc as a remedial agent, doubtless originated in the notion that the surface of the joint would be levelled, and thus produce a reduction of the amount of pressure bearing upon it, but the results are undoubtedly

FIG. 1.

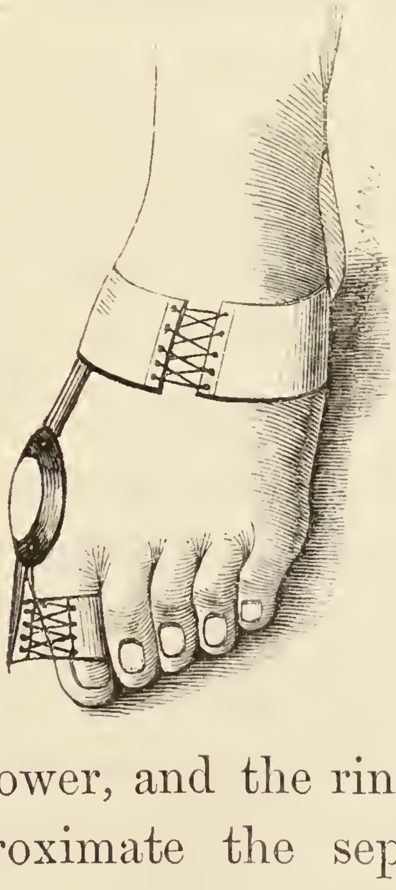


the very opposite to this. Such an arrangement then is clearly fallacious.

There are two methods in which a bunion may be treated scientifically; in one, a slight trough of leather is carefully moulded to the internal margin of the foot, so shaped at its anterior extremity as to assume the direction which would be followed by the long axis of the great-toe, if in its normal condition. This should be attached to the instep by a strong though thin-laced band, a prolongation from which should pass around the heel, in order that the apparatus may be kept from slipping forwards, the extremity of the great-toe being carefully strapped within the trough. By this apparatus an action is obtained, the very opposite to that produced by the disc of leather, or soap-plaister. The metatarsus, in this case, is a fulcrum, against which the lever which is to reduce the toe to its normal horizontal line can act powerfully, and all attempts of the boot, &c., to press on and increase the bunion, are at once arrested, every encouragement being meanwhile afforded for the gradual absorption of the callous tegumentary portion of the deformity. This plan can be adopted with great success in slight and ordinary cases, yet when the malformation is of long standing, it becomes necessary to employ a more complex and powerful apparatus. This consists of a delicate lever of steel, with an annulus in its centre correspondent with the deformity at the joint, and attached by a laced band to the instep;. at the anterior and posterior margins of the oval ring, the lever has an ordinary hinge-joint, allowing the articulation to act freely in the natural plane, but calculated to oppose lateral tendency. The anterior portion of the lever is uniform in length with the toe, forming a spring the force of which acts inwardly.*

When the great-toe is secured in this apparatus, that portion of the lever which is placed at the instep becomes the lateral fulcrum; the spring is the power, and the ring tends by its shape to approximate the separated lateral

FIG. 2.



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* The term inwardly must be understood to bear relation to the mesial line of the body.

margins of the joint. The preceding sketch explains the action.

If carefully constructed, an ordinary shoe may easily be worn over this apparatus, and as the joints allow a free motion to the foot, walking is unattended with any difficulty.

It is a matter of much regret, that shoemakers cannot be induced to comprehend the necessity of so constructing their boots that a straight line may be drawn from the great-toe to the heel, and also that the *tread*, or distance allowed for the lateral play of the joints, is not made broader than at present. The boots would not lose in elegance, whilst the natural requisitions of the foot would be better cared for than at present. Another great evil which tends to produce bunions, is the adoption of an absurdly high heel for ladies' boots: the mechanical consequence of this being, that the plane of the foot no longer maintains its normal horizontal position, but is rendered oblique; while the gravital line of the body, ceasing to pass through the centre of the foot, falls with unnatural and injurious force upon the phalangeal extremities, tending in this way to spread, and consequently weaken, their ligamentous attachments to the bone of the instep (metatarsus), as has already been stated, disposing the articulation in such a manner as to excite the formation of a bunion in due time.

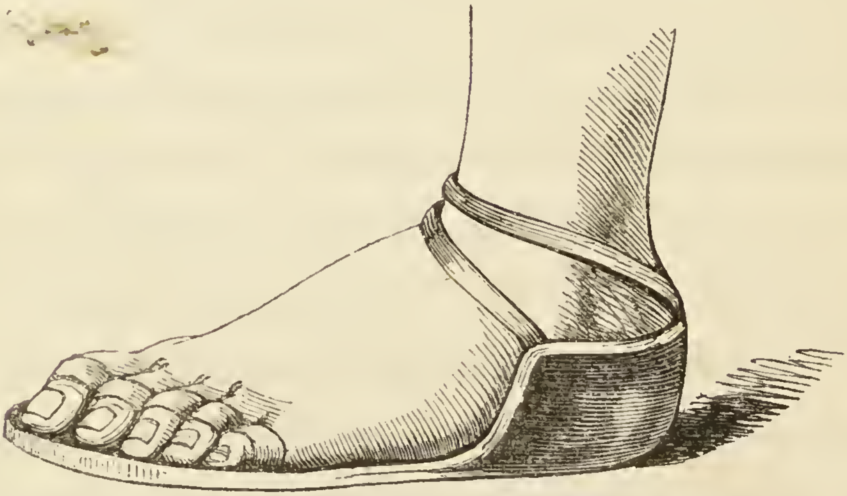
Lateral expansion of the metatarso-phalangeal joints is not confined to the great-toe alone; it takes place, though rarely, upon the little one. A similar mechanical apparatus, suitably adapted to the outer margin of the foot, suffices for the remedy of this malformity also.

In addition to bunion, muscular contractions at the phalangeal articulations, whether downward, upward, or lateral in direction, require mechanical force for their resolution. The first of these deformities is usually termed "hammer-toe," anatomically arising from the contraction of the tendon of that muscle which is known as the "Flexor longus digitorum," this muscle arising from the upper part of the tibia (leg bone), and being inserted by four separate tendons into the last phalanx of the four lesser toes. The mechanical action of these tendons is peculiarly calculated to promote contraction of the toes, as, prior to their insertion into the distal phalanx of each small toe, the tendons perforate the extremities of another muscle, the "Flexor brevis," gaining hereby (at least such is my opinion) an increase of force calculated to act powerfully in flexion of the toes. To decide with nicety the difference in power exerted by the extensor as compared with the flexor tendons of the toes is very difficult; but most decidedly, the latter are the more vigorous of the two, this being the established rule throughout the human body. Taking it therefore as granted, that the contraction of the toes in their mesial line, is due to shortening (structural or otherwise) of the flexor tendons, a correct knowledge of the mechanical principles upon which they must be treated, becomes absolutely indispensable.

If the restraining power was purely referable to the contracted state of the flexor tendons, the deformity would be instantly removed by a division of them: for, as has already been stated, the flexors being normally, and still more when contracted, stronger, *per se*, than the extensors, division of the former muscles would render the balance of power largely in favour of the latter; but it must be remembered that the extensors are unable to avail themselves, if unassisted, of the superior motive power thus acquired, partly from *mechanical and positional causes*, partly because the joint is still kept in a bent or angular form by the shortening of the lateral and inferior phalangeal ligaments, which are sure to become contracted when the toes have been kept flexed for any considerable length of time. This ligamentous contraction, then, can only be overcome by applied mechanical agencies.

There cannot be the least doubt that a division of one or both of the flexor tendons is, in almost all cases of structural contraction, a most valuable—nay, indispensable—adjunct to the mechanical treatment. In slight cases of "hammer-toes," however, it will generally be found that the deformity may be overcome, and the toes extended, by mechanical means alone, provided that the appliance used be scientifically devised and carefully adjusted. The chief point for attention, in all cases, is the taking care to make pressure upon the knuckle or superior angle of the contracted joint, leaving sufficient space in the front of the apparatus to allow the distal phalanx of the toes (last bone) travelling forwards, while the joint is being gradually extended. For the extension of a toe which is simply contracted at the second and third phalanges, I generally construct a well-padded shoe, perforated with long slits correspondent to the inter-digital spaces; through these apertures pass small strips of webbing, which enclose the toe, the tightening of which on the under surface of the shoe necessarily extends the contracted joint; it also lengthens the foot by stretching the tendons of the flexor longus digitorum muscle. I give here a sketch of the shoe.

Fig. 3.



When, as occasionally happens, *both* phalangeal joints are contracted in a downward direction, division of the flexors affords immense assistance to mechanical treatment. The apparatus is arranged as follows:—A small steel socket is fixed to the metal sole-piece of a "Scarpa's shoe,"* on that margin which corresponds to the contracted toe; this socket has its direction transverse to the toes, at their metatarso-phalangeal articulation. Into this socket is fitted a metal stem, so shaped as to arch over the toes, until it arrives at the metatarsal extremity of the one which is contracted; at this point it is joined by a second lever, which runs in a line with the long axis of the toe, and is attached to it by a tangential screw joint, while from the distal extremity of this second lever there is a small strip of webbing, which passes beneath and confines the toe; by means of the screw, we are enabled to upraise the lever, and thus at the same time bring the toe into its normal straight and horizontal position. Uplifting of the anterior part of the foot, in lieu of the toe or toes, is effectually prevented by two dorsal straps, which firmly secure the instep to the shoe. The only reason for attaching the arched lever to the shoe by a socket is, that it admits of being more readily placed *in situ* after the shoe has been carefully adapted to the foot.

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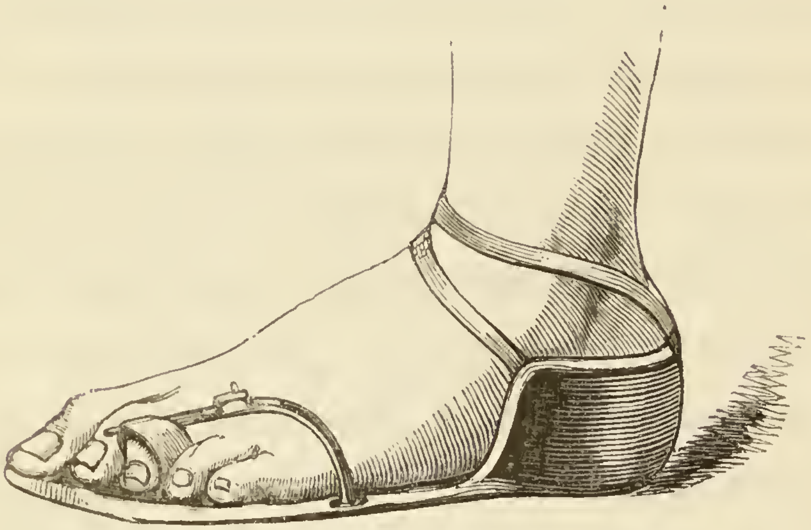
* *Vide* page 33.

Fig. 4.



I need scarcely add, that in very severe cases the lever can be furnished with a tangential screw for each joint, in which case care must be taken to make each separate centre of articulation coincident with that of the corresponding axis of the lever.

CHAPTER II.

DEFORMITIES OF THE FOOT AND ANKLE.

TALIPES.

"TALIPES VALGUS," or lateral yielding of the ankle-joint combined with extension, and sometimes *obliteration* of the arches which compose the plantar surface or sole of the foot, is among the most common of those pedic deformities which call for mechanical treatment.

Talipes Valgus is divisible into three degrees of severity, each of which is treated by means of a suitable but distinct apparatus, the mechanical actions being based upon the peculiar anatomical conditions present in the variety under consideration.

The first, and least severe form of valgus, is that in which the inner ankle is laterally inverted, with slight extension of the plantar arch. This deformity is principally met with in children, and is commonly termed "in-ankle."

The appliance used in cases of this description consists of a leathern boot laced to the toes, rendered stiff on the inner side, and furnished with an india-rubber pad shaped like the quarter of an orange; the convexity of which, being opposed to the depressed plantar arch, forms a kind of stay or buttress, thus tending to restore the arch to its original form, strengthening the plantar ligaments at the same time. The elasticity of the material affords but a slight chance of an abrasion of the skin, even where the scaphoid tuberosity is unusually prominent. In addition to the support which the pad gives to the flattened instep, the stiffener at the lateral margin of the boot cannot but uphold the inner ankle (malleolus), and aid in giving a firm *point de résistance* to the pad, while it also prevents abduction, or out-turning of the foot; a triangular strap, likewise fixed to the external surface of the boot, and beneath the inner malleolus, is calculated to afford support in place of the deltoid ligament —generally weakened in these cases. Another plan of mechanical treatment is occasionally adopted in slight cases—viz., the insertion of an arched metal plate between the soles of the boot; but this is objectionable on account of the unyielding nature of the force exerted against the depressed plantar surface.

In every case it should first be decided whether division of the tendons be advantageous, or the contrary. In ordinary cases of valgus, there can, however, be but little doubt that, as the muscles named "peronei" aid in uplifting the external margin of the foot, division of their tendons will often materially lessen the period of mechanical treatment, by instantly removing one of the main obstacles; nevertheless, a large proportion of cases recover without operation, and the patient suffers no other inconvenience than that of wearing a pad within the boot. The fixing of an elliptical piece of leather externally to the inner margin of the heel, improves the appliance vastly, as by giving obliquity to the tread, in a direction opposite to that in which the arch is depressed, it greatly facilitates the action both of pad and stiffener.

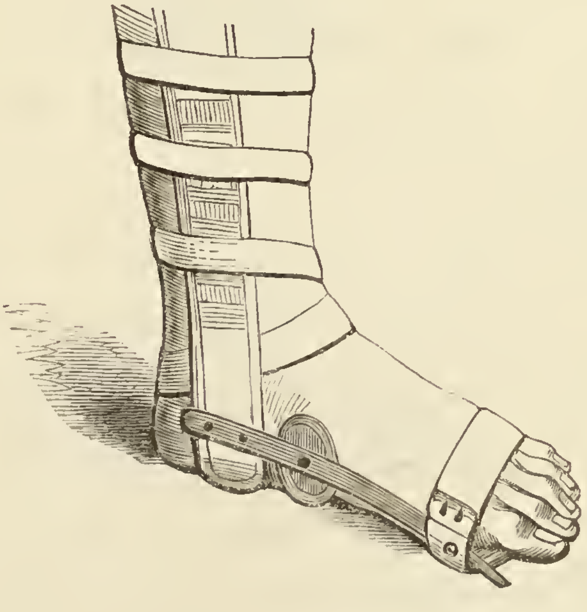
In the form of valgus just noticed, the full extent of the plantar depression is best exhibited, when the weight of the patient falls on the foot, as in standing. When tenotomy is resorted to, other forms of apparatus must of course be employed; these, however, will be described with the contrivances used for the treatment of this deformity when of a more decided character.

The second degree of talipes valgus is mechanically distinguished by entire obliteration of the plantar arch, uplifting of the external margin of the foot, and considerable abduction of its anterior two-thirds. Obliteration of the arch is said to be referable to a relaxation of certain muscles and ligaments at the sole of the foot, especially of the great cubo-astragaloid ligament; uplifting of the margin, to contraction of those muscles which raise and rotate the foot outwardly; and abduction of the anterior two-thirds, to downward displacement of the scaphoid bone, entailing a separation of its tuberosity from the astragalus.

So many forms of apparatus are employed for the treatment of valgus in the second degree, that the space of this work will not admit of my describing more than those most generally adopted.

The first, then, consists of a wooden splint, having at its inferior extremity a horizontal spring, furnished with a sliding oval pad. When adjusted, the splint is so secured by a roller bandage to the inner side of the leg, that the pad rests against the scaphoid tuberosity; a webbing strap is then passed around the toes, and drawn to the spring by means of a buckle, the mechanical result being, that the pad becomes a fulcrum for the uplifting of the plantar arch, while the spring acts as a lever in overcoming both the muscular traction and abduction of the foot. It will readily be seen that, in this simple form of apparatus, there is a manifest deficiency of one condition—viz., power of changing the obliquity of the sole, which, both in valgus and varus, offers a great

Fig. 5.

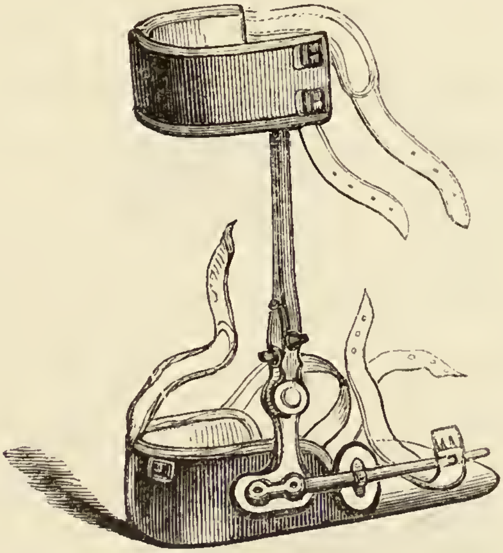


obstacle to the mechanical treatment for restoring the limb to its normal condition. This apparatus is therefore ill adapted for cases in which there is *very marked* obliquity of the metatarsus.

Another apparatus is thus constructed:—A padded metal shoe receives the foot, a perpendicular stem being fixed on its inner margin, just below the internal malleolus, with a tangential screw-joint opposite to the axis of the malleolus; above this point, at right angles to its plane of direction, another screw is adapted; a metal bar, horizontal with the foot, and secured to the inner heel-piece, gives attachment to a sliding pad, and from the end of this bar three metal studs project, which serve to fix a webbing toe-strap. When applied to the leg, the foot is kept *in situ* by three straps passing over the instep, one of which springs from the back of the heel-piece, and the lateral stem is secured to the leg by a padded calf trough; the toes are likewise kept from abducting by the webbing strap which belongs to the horizontal stem.

The mechanical action induced on bringing the apparatus into play is, 1stly, an uplifting of the plantar arch; 2ndly, a depression of its outer margin with adduction of the toes, which is accomplished as follows:—When the toe-strap is drawn tightly towards the horizontal bar, the sliding pad is powerfully brought into contact with the projecting scaphoid bone, and a tendency to an uplifting of the arch is at once established; the foot-piece must then be extended by moving the ankle-screw in such a direction that the toes may point downwards; it now becomes necessary to turn the upper tangential screw in such a manner, that the sole of the foot-piece may be depressed at its external margin. The united result of these

Fig. 6.



several actions is, an uplifting of the arch of the foot, adduction of the toes, and a decrease of obliquity in the sole; finally, the foot must be brought into its normal position by reversing the action of the ankle-screw.

It is, of course, to be understood that the apparatus just described would not be applicable, save in cases where tenotomy has been performed, *prior to its adoption.*

A third apparatus is that in which springs are employed in place of stiff metallic bars, the mechanical actions, nevertheless, being precisely identical.*

A fourth kind is thus constructed:—The foot is received by a metal shoe-piece, and a horizontal toe-bar, with a webbing strap, controls the toes; but there is a very peculiar deviation from the ordinary construction in the leg stem, which, instead of being placed at the inner margin of the heel-piece, is fixed to its posterior border, and surmounted, at a point exactly corresponding with the long axis of the foot, by a tangential screw, the other extremity carrying the usual tangential screw ankle-joint, which thus forms part of the leg stem, as in the second apparatus. The mechanical power of an instrument thus constructed is very great, as it is able, by a special action, to depress the external margin of the foot and upraise the arch simultaneously—an advantage which cannot be over-rated. This action may be thus explained:—

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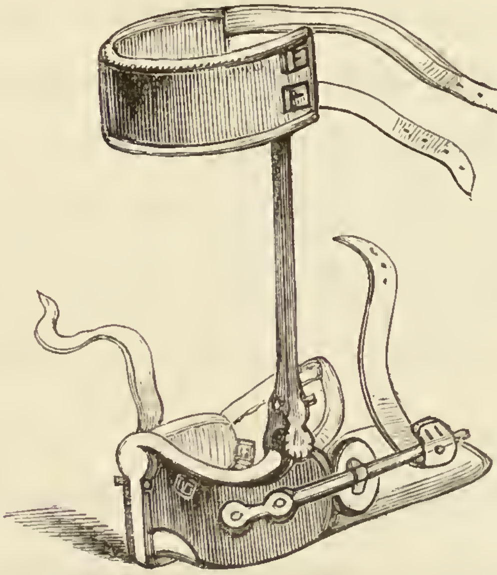
* One great objection to metallic spring power being used in these cases is the impossibility of regulating, with anything approaching to certainty, the force employed; hence, abrasion is much more likely to result than when the tangential screw is adopted.

When the foot is secured in the metal shoe-piece, and the toe-strap tightened, there is

Fig. 7.



pressure against the scaphoid bone, as in the other mechanical appliances aforesaid; but when the screw is applied to the posterior joint, the entire foot is rotated around its major axis, thus inducing, at one and the same time, an uplifting of the arch, and depression of the external margin.

The principles laid down as being essential for the mechanical treatment of valgus, are decidedly more strictly adhered to in this than in any other instrument; for the posterior screw is correlative with that point in the great tarso-metatarsal joint, around which the anterior two-thirds of the foot rotates while the external margin of the metatarsus is being uplifted; the horizontal bar being likewise always brought into the same plane as the metatarsus, drawing it downwards and outwards whilst in action. The tangential ankle-screw, also, helps to uplift the arch in the restoration of the foot to its normal position (at right angles with the leg), by depressing its anterior part. It is an invaluable instrument.*

Valgus of the third degree is of very rare occurrence, since pain, an invariable concomitant of valgus in the earlier stages of the second degree, indicates the necessity of treatment, and thus prevents a neglect of the deformity. When, however, this very severe form comes under surgical care, the apparatus employed for its reduction is generally similar to the one last described, with the addition of a ratchet-jointed lever and pad fixed to the internal margin of the heel-piece, the mechanical "set" of which, being in a more oblique direction than that of the toe-bar, it thus becomes a powerful fulcrum for the uplifting of the scaphoid, with adduction of the front of the foot. This form of lever, aided by the posterior screw, is calculated to be highly beneficial in severe valgus. Occasionally, however, even this instrument is inapplicable by reason of an unusually large amount of abduction. The mechanical treatment must then be divided into two stages.

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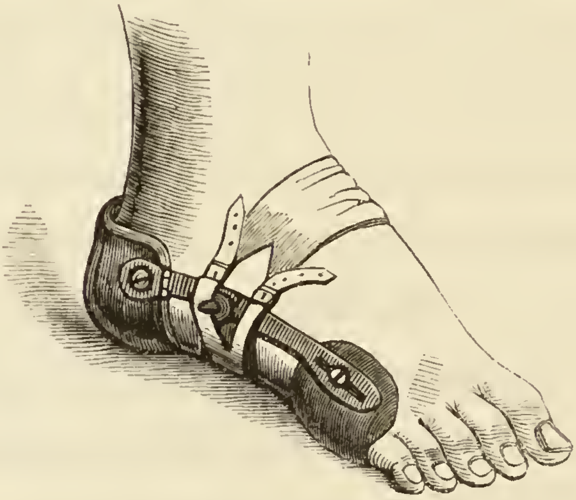
* The credit of inventing this instrument is due to Dr. Langard of Hamburgh.

For the first, it is necessary to use a slight stem of steel with a free joint at the ankle, which is attached to the leg by an ordinary calf-band, and fixed to it, (in contradistinction to all other instruments for valgus,) on the outer side of the leg, a lever, hinged perpendicularly at its point of attachment, and having a small padded plate resting against the calcis. At the centre of this lever, in correspondence with a depression situated just above the cuboid bone, there is placed a ratchet joint, and at its digital end a padded plate, which rests against the whole length of the first metatarsal bone. From the ratchet's centre, a strong webbing passes over the dorsum of the foot, embracing the scaphoid tuberosity.

Fig. 8.



Upon bringing this apparatus into action, the first point of resistance is at the scaphoid, the next at the metatarsus and os calcis; hence, the lever forms the base of a triangle, at the apex of which is the projecting scaphoid, and, as the lines of mechanical power act in direct antagonism to the perverted forces, the metatarsus is forced downwards, and the scaphoid uplifted; the usual action being thus reversed, yet with the same result as is obtained with the other appliances, for with them the metatarsus is *drawn downwards,* whilst by this it is *thrust downwards.*[*]

In the second stage of treatment, it is simply requisite to employ the ordinary apparatus used for valgus of the second degree, as described at p. 33.

The importance of tenotomy is so widely acknowledged, and its adoption so general, that it is scarcely necessary to observe, that all the instruments which I have described as applicable in valgus of the second and third degrees, are nearly useless apart from this operation.

In what is commonly termed "flat-foot," a condition of valgus which merely involves a depression of the arch of the foot, the proper mechanical appliances *alone* suffice to restore the lost symmetry.

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[*] This is a new invention, and only recently applied.

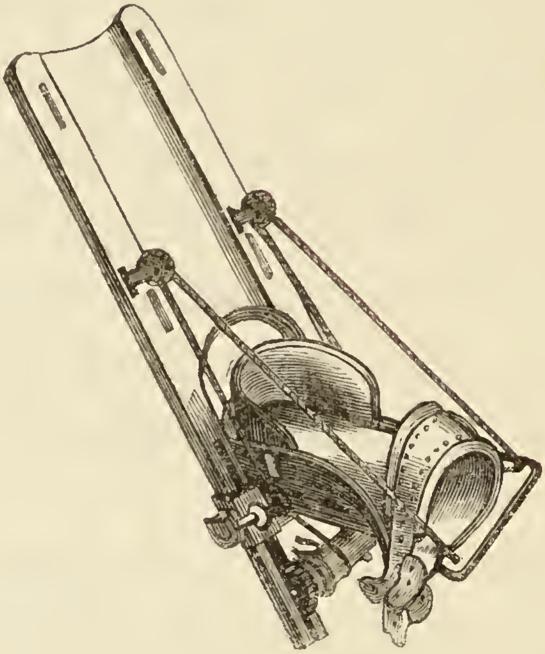
Apart from the scientific reasons which might be advanced in favour of tenotomy—which are omitted as foreign to the scope of this work—the tissues in the human body are so delicately organized, that our most careful mechanical calculations are often, in spite of all our care, rendered void by the irritability of the vital substance on which we endeavour to act. However correct in theory, or perfect in all its scientific details, an instrument, when in actual operation, may fail, simply because the living tissues are unable to bear the pressure necessary for the overcoming of muscular resistance. It is under such circumstances that tenotomy offers a real boon, not only to the surgeon, who can now treat deformities with success and certainty, but likewise to the mechanist, whose labours are marvellously lightened by every reduction in the number of the forces which have to be opposed and overcome by his instrument.

I now pass on to the consideration of another deformity of frequent occurrence—"Talipes Equinus," popularly known as "horse-heel," the chief anatomical characteristic of which is a permanent contraction of the tendo Achillis, which uplifts the os calcis—the posterior pier of the plantar arch—to such an extent, as to cause the whole weight of the body to pass through the front of the foot only, thus destroying the natural heel-and-toe action during progression. In a mechanical point of view, talipes equinus is more easily reduced than any other deformity of the foot, and we find that practice has proved the correctness of this theory; indeed, the palpable simplicity of the malformation was in all probability the main reason of its having been selected for the earliest attempts of modern orthopædic surgery.

Pure talipes equinus, *i.e.*, equinus unaccompanied by any lateral deflection of the longitudinal axis of the foot, rarely, if ever, exists; since the moment the base of support given in the normal state by the whole of the foot, is transferred to the metatarso-phalangeal extremities, a tendency is immediately generated for inward contraction of the arch of the foot in strong persons (equino-varus), outward expansion in weak ones (equino-valgus). Taking it for granted, however, that pure equinus *is* occasionally met with, I give the following appliances as being those which are most usually employed for its reduction.

The first is termed "the foot-board of Stromeyer."*

Fig. 9.



It consists of a piece of wood, shaped to the sole of the foot, and secured at the heel-axis to a wooden splint, upon which the back of the leg is kept in position by means of straps.

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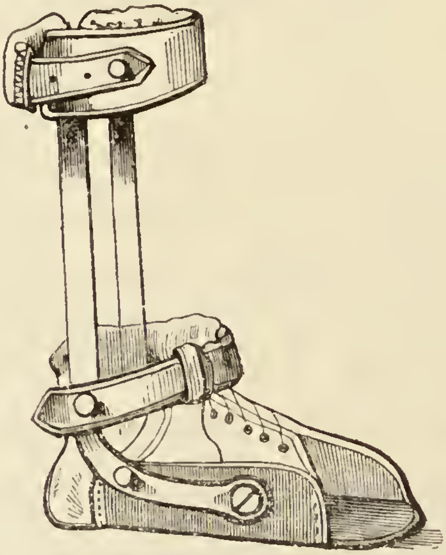
* This form of instrument is rather clumsy: but as it has been advocated in the pages of one of the best works upon Orthopædy, I feel bound to give it insertion amongst other appliances: the drawing is copied from Dr. Little's work.

The foot-board is flexed upon the leg by pulleys, so that, since the foot is secured sufficiently firmly to prevent uplifting at the heel, extension of the tendo-Achillis necessarily ensues. It is, nevertheless, a very crude contrivance, as it entails confinement to bed during the whole period of treatment, which is of course extremely irksome to the patient. Moreover, it is decidedly incorrect in its action, mechanically speaking, for the centre upon which the foot-board moves, does not coincide with the axis of the malleoli, a point which should be kept strictly in view in the scientific reduction of equinus.

A far better instrument for the cure of this deformity was suggested by the late eminent Mr. Liston. This consists of two curved levers, joined at their upper extremity by a padded leg-band. A metal shoe is fixed to their lower ends, rotating between them at the points of junction. A padded strap, passing over the dorsum of the foot from that part of the lateral levers which coincides with the astragalus, becomes a fulcrum, against which the lateral levers act in such a manner as to depress the heel while the toes are uplifted.

Mr. Liston called this apparatus a "Lever Instrument," as he rightly conjectured that the leverage of the lateral curved bars would act more directly and simply upon the uplifted instep in this, than in any other more complex contrivance. An important point gained in this apparatus was, that the act of walking facilitated the descent of the heel, by elongating the contracted tendon, whereas, even if walking had been possible with Stromeyer's foot-board, extension of the tendo-Achillis would have been prevented, on account of the bodily weight being thrown upon those cords

Fig. 10.



which uplift the toes. In the one apparatus the heel would descend, in the other the toes would be raised; here then, there cannot be the slightest difficulty in determining which of these mechanical actions is most consistent with a scientific reduction of the deformity.

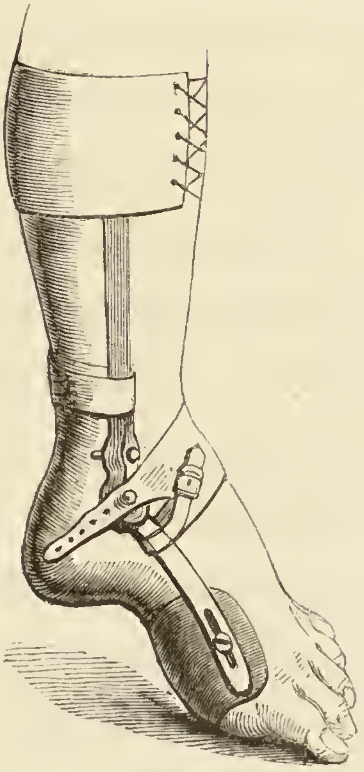
The principle of action in Mr. Liston's instrument, may be explained by showing that it assumes, as its fixed centre, a point coincident with the metatarso-phalangeal articulation, by moving on which it compels the uplifted heel to descend in the arc of the periphery, or external boundary, of a circle, the radii of which would be represented by lines passing from the common centre to the extremities of the piers of the antero-posterior arch of the foot. It has often been objected to, on the ground that it exercises little or no control in preventing a too sudden elongation of the tendon; this objection, however, can be easily removed, by the fixing of a strap and buckle to the heel-piece, by which it may be secured to the calf-band, and thereby at once preventing the depressing force exercised by the instep-strap from being carried out to a greater extent than is considered advisable.

I have recently constructed an apparatus of a very novel description, for a severe case of talipes equinus, but, as the malady requiring mechanical aid was characterized by a remarkable shortening of the plantar arch, with a displacement of the astragalus in an anterior direction, I deviated from the principles acted upon in the construction of the ordinary instruments, in the following manner :—Two curved levers of metal passed downwards on either side of the leg, similar, so far as regards the degree of their angularity, to those used by Mr. Liston. These levers terminated, anteriorly and inferiorly, in a metal plate, which passed under the metatarso-phalangeal articulation. A ratchet joint was attached to each curve, at a point coincident with the articulation of the astragalus and calcaneus with the cuboid and scaphoid bones.

The foot was secured in this apparatus by means of three straps, two of which passed over the instep, the third just above the ankle.

When the instrument is brought into action, the anterior two-thirds of the foot are uplifted, a process which consequently brings about an elongation of the plantar arch, at the same time that it restores the astragalus to its normal position in relation with the trochlear surface of the tibia. The anterior extremities of the curved levers rotate around the screw-centre, and as the plate which is placed beneath the toes obtains an elevation proportional to the radius, passing from the centre-ratchet to the extremity of the lever, a stretching of the plantar arch is secured by their united actions.*

Fig. 11.



Another apparatus, and that which is most generally used in the treatment of talipes equinus, is constructed as follows:—A perpendicular lever, from which a horizontal stem runs along the length of the foot, is fixed to the leg by a calf-band, and attached at its inferior extremity to the external lateral margin of a well-padded metal shoe-piece. In that portion of the leg-stem which is opposite to the ankle-joint an axis is placed, governed by a ratchet and screw, while the shoe-piece is bound to the foot by two straps, which pass over the instep, a third surrounding the toes, and securing them firmly against the horizontal foot-stem. Flexion of the foot upon the leg, is induced by the mechanical action of this apparatus, and thus:—Upon moving the screw at the ankle, the angle made by the foot-piece with the perpendicular lever is rendered less obtuse than that which it held in the original condition of the equinus, and as the foot is secured to the shoe-piece beyond all chance of displacement, any deviation of position in the latter, affects the former in an equal ratio, whilst the tendo-Achillis, the principal obstacle to free flexion of the ankle, is proportionately extended. Although this is undoubtedly well-known, yet it is as well that the intention of the apparatus should be explained, in order that its mechanical action may be the more perfectly comprehended. This form of instrument is also strongly advocated, in consequence of its giving a perfect control over the amount of lengthening which the surgeon may wish to give to the tendo-Achillis, since a *too rapid extension* of the "callus," or new plastic matter, which, exuding from the divided ends of the tendon, and, from its capability of being stretched to the required length, admirably restoring the tendon to its normal efficiency, entails an attenuation and consequent weakening of the tendon after tenotomy, which is highly undesirable.

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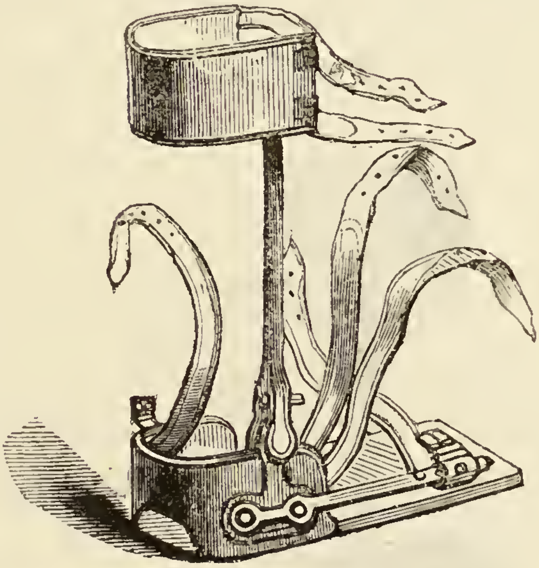
* This instrument I constructed for a patient of Mr. Adams.

Whilst on this subject, although it is rather foreign to the purpose of this book, which is merely intended to describe the various instruments which are most generally applicable in the treatment and cure of deformities, only so much anatomical matter being embodied in it, as is absolutely necessary in order that their application may be rendered intelligible, I may as well give a simple explanation of the ends proposed in surgical division of the tendons, and the manner in which it advances and aids the mechanical treatment. The primary object in tenotomy is that of lessening the mechanical resistance offered by a tense and contracted tendon, and it has been triumphantly demonstrated by Stromeyer, Cruveilhier, Little, and others, that when a tendon has been divided by subcutaneous section, the surfaces, if kept in apposition, become conjoined again, and that the new material, by which they are united, is so far from offering a resistance similar to that met with in the original state of the tendon, that it can be readily extended to as great an amount as may be desired, and, in addition to this, possesses the extraordinary property of increasing in substance, until it has acquired a calibre equal to the transverse area of the tendon from whose divided ends it was exuded. This explanation, if intelligible, and likewise correct, sufficiently shows the importance of avoiding too rapid an extension of the callus, and of allowing it a sufficient period for strengthening itself by increase of tenacity after each elongating strain which is applied by the apparatus. This interval of rest, so far as the mechanical traction is concerned, is much better secured by the movement of an axis which can be gradually brought into active force, than by one offering no opposition to an improperly rapid elongation of the uniting callus. A representation of the apparatus is here given, and I need scarcely say that its adoption in these cases is all but universal.

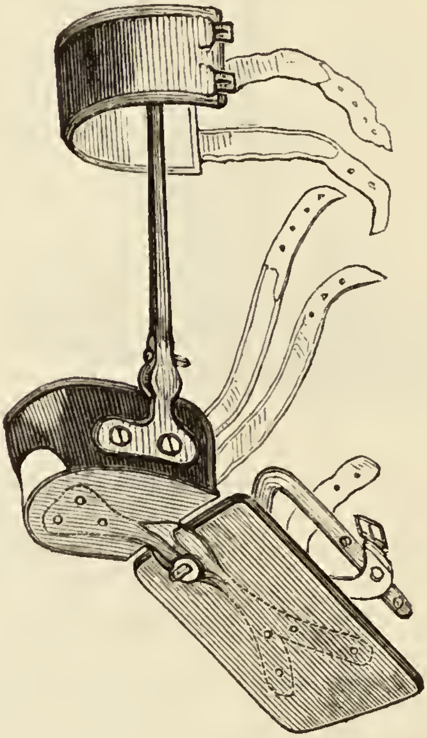
FIG. 12.



I have purposely abstained from giving any elaborate description of the spring instruments which are occasionally employed in the treatment of equinus, as I do not consider that their mechanical principles are perfect, owing to a probability of a too rapid extension of the tendons, since there is no arrangement made in their construction, by which the depression of the heel part of the apparatus may be regulated. Briefly, they resemble the instrument shown above in all respects save one—the substitution of a tempered steel spring, *moving on a free axis below the external malleolus,* in lieu of the stiff perpendicular stem, with a ratchet ankle-joint.

Sometimes, in addition to the elevation of the heel, there is a considerable lessening of the plantar arch. The instrument which is best calculated for the counteraction of this complication is thus constructed.

Fig. 13.



An ordinary foot-piece is divided into two parts, one receiving the heel, the other, the sole of the foot; a ratchet joint, coincident in the direction of its action with that of the mesial line of the foot, uniting these two portions. A horizontal metal bar, carrying a toe-strap, is attached to the external lateral margin of the anterior of the two divisions; whilst the posterior, or heel-piece, has a perpendicular stem, with a ratchet ankle-joint fixed to it. The foot is secured from displacement, on the instrument's being put into action, by two straps which pass over the dorsum.

When this instrument is to be applied, the ankle ratchet joint should, first of all, be turned, until the apparatus has been made to assume an angle equal to that formed by the heel and leg. The anterior plate of the shoe must then be so depressed, by means of the *plantar*-rack, as to coincide with the line of direction held by that portion of the foot upon which it is intended to act. The toe and instep straps ought now to be drawn tight by means of their several buckles. The mechanical actions called into play, on the due performance of these several steps, are as follows:—

The extension of the ankle-ratchet, coinciding as it does with the centre upon which the calcaneus and astragalus rotate during an uplifting of the heel, necessarily depresses the heel, while it also elongates the contracted tendo-Achillis, and, at the same time, uplifts the front of the foot. In this latter action, however, the anterior extremities of the metatarsal bones offer the greatest amount of resistance; consequently, the abnormally-shaped arch is *raised*, without being *expanded*. This difficulty, however, is got over by the action of the plantar ratchet-joint, which unites the two pieces of the sole-plate. By moving this screw, the longitudinal arch is lengthened, and the entire plantar surface being then acted against, instead of the metatarsal extremities alone, the breadth of the foot is increased; the foot, at the same time, being held in its correct position.

In this way a distortion, such as I have described, may be reduced, without pain or inconvenience to the patient.

CHAPTER III.

DEFORMITIES OF THE FOOT AND ANKLE.

TALIPES VARUS.

It is my intention to commence the present chapter by attempting to render intelligible to its readers the mechanical construction and actions of the instruments used in the reduction of one of the most difficult, perhaps the most important, of all the many deformities incidental to the human foot, viz., Talipes Varus.

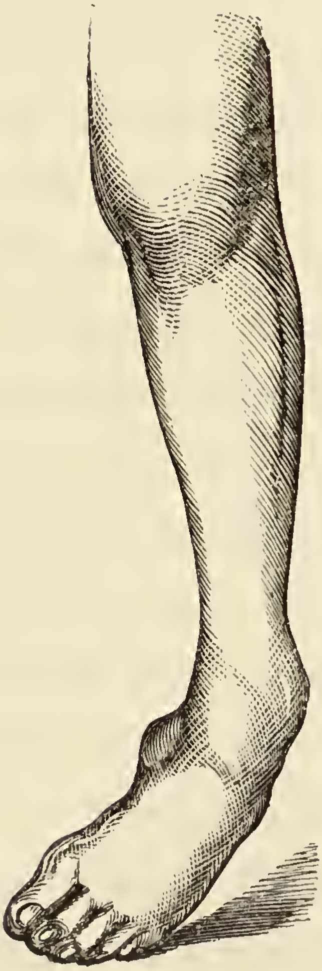
This very disfiguring malady is mainly characterized by an uplifting of the heel, adduction, or turning inwards, of the toes, and consequent sinking of the outer ankle towards the ground, to a greater or less extent.

Looking at Talipes Varus in an anatomical spirit, we discover that the position just described is referable to a displacement of the bones composing the tarsus, or instep. The following explanation is undertaken with the view of rendering this form of club-foot popularly understood; and, as it is an exceedingly common malady, may not be unworthy of attention at the hands of the general reader.

The tarsal bones (those composing the heel and instep) are seven in number, and are severally amenable to the traction of various muscles which are attached to them; to such an extent even, as to be capable of assuming various changes of position and mutual relation, when strongly under the influence of any particular set. These bones, being also articulated, both *inter se*, and with the metatarsal bones composing the anterior part of the foot, by powerful ligaments, which undergo considerable elongation in club-foot, in a direction corresponding with the changed position of the bones.

One of these bones is named the "Scaphoid," or "boat-shaped" bone, on account of a peculiarity in its form. Its concavity articulates with a large bone (the astragalus), which receives, on its upper surface, the concave extremity of the leg bones; on this astragalus, the scaphoid bone is capable of moving horizontally. Now to the inner side of the scaphoid a very powerful muscle is attached, which (taking origin, as it does, from the tibia, or greater leg-bone), when retracted, brings the anterior two-thirds of the foot inwards, by moving the scaphoid obliquely against the astragalus; thus, at once, accounting, to a considerable extent, for the adduction or in-turning of the foot, which is one of the symptoms of ordinary club-foot. There is, however, another action, which greatly contributes to the maintenance of ad-

Fig. 14.



duction—uplifting of the os calcis or heel-bone, the result of a contracted state of the gastrocnemius and soleus muscles, both of which end in, and are attached to, the heel, by one powerful common tendon, which I have often made mention of, the "tendo-Achillis."

Lateral inversion is increased by this uplifted position of the os calcis in two distinct ways: firstly, because the thrusting forwards of the astragalus not only favours, but even generates, a tendency to lateral displacement of the scaphoid; secondly, because the supporting surface of the sole of the foot is so diminished that the patient is compelled to rely for support, while walking, upon the external margin of the anterior two-thirds only, or, in common parlance, *the toes.* I ought to state, however, that the peculiar form of the scaphoid, and the mode in which it is connected with the astragalus, allow it to undergo a certain amount of rotation on its own axis, which, of itself, aids in the establishment of obliquity in the sole of the foot.

Surgical writers divide Talipes Varus into three degrees of severity. In the first and slightest, there is inversion of the metatarsus, trifling upraising at the heel, and but little obliquity of the sole, the proximate cause of this last symptom being a contraction of the tibiales, posticus et anticus, and the muscles which end in the tendo-Achillis. In the second, great adduction of the metatarsus, with considerable oblique displacement of the scaphoid bone around the anterior surface of the astragalus; uplifting of the os calcis, and an arching outwards of the tarsal bones, so that the cuboid becomes remarkably prominent, are the most marked features. In the third, we invariably find that a long maintenance of all these conditions has actually brought about a change of form in the very bones themselves,* so that the patient is absolutely compelled to walk, though with great pain, upon the dorsum of the foot.

I considered it right that I should enter thus much into a semi-popular demonstration on club-foot, for when I call to mind the unusually great prevalence and vast social importance of this deformity, together with the interest inspired by its successful treatment at our large hospitals and elsewhere, I feel assured that my professional readers will hold me excused, for attempting to render the malady so intelligible to the wearers of the various apparatuses employed for its successful removal, that they may readily be able to appreciate the necessity of implicitly following the directions of their medical advisers.

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* *Vide* Brodhurst on Club-foot, page 35.

Prior to a description of the various mechanisms which are necessary for the treatment of these three divisions of varus, I must touch briefly upon the relations which some of the tarsal bones bear to the centres around which they play.

In a normal state of the foot, the axis of its motion with the leg is situated in the tibio-tarsal joint (*i.e.*, so far as flexion and extension are concerned), the surfaces of which are nearly horizontal, sufficiently so, practically, at all events, for the performance of the various motions of the foot in its mesial plane. The axis of motion on which the external and internal margins of the metatarsus are alternately lifted or depressed, is likewise referable to this point, as is also that of horizontal rotation, though this last is seldom of marked importance. Thus the various motions which *the foot as a whole* is capable of receiving are all dependent upon one common centre of motion in the tibio-tarsal articulation.*

The most restricted of the above movements between the foot and leg bones are those in horizontal and lateral directions; it must therefore be evident that, since there is very great lateral displacement in cases of varus, motion must be set up from some other centre, in place of the normal and true one. Now, if in pursuance of this idea, we take the trouble to examine a dissected preparation of a club-foot, we shall find considerable yielding at that part of the foot anterior to the astragalus, which is immediately suggestive of the true state of the case, viz., that the lateral movement of the scaphoid upon the head of the astragalus can alone account for so great an amount of adduction. Hence we infer the existence of a centre of motion at some point in that part of the foot in which is situated the articulation of the astragalus and os calcis with the cuboid and scaphoid.

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* *Vide* the *Lancet*, 1857, Vol. 2, p. 267 and 518.

Modern writers on orthopædy bring forward ample evidence in favour of this theory.*

Since an uplifting of the heel deprives the astragalus of a portion of the anterior support hitherto given to it by the scaphoid, it is thrust unduly forwards, so as to become prominent upon the dorsum of the foot, advancing at the same time, in such a manner as to obtain a new centre of horizontal movement, apart from, and in front of, that point, which is, in the normal state of things, the common centre of motion in the ankle-joint. By these changes, two of the motions of the normal foot undergo a deviation from their natural course and centres of motion, a circumstance which imperatively necessitates that the mechanism intended for the treatment of varus be calculated to act in coincidence with the changed directions of the deformed foot, and to facilitate the restoration of the limb to a normal condition, by being so constructed that its centres of motion shall be placed at the points of deviation. How this desideratum may be accomplished, I shall best show by giving a detailed description of the more leading of the numerous appliances which are daily constructed for the cure of the distortion under consideration.

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* *Vide* Adams's Lectures, *Medical Times.*

I shall commence by describing the plan pursued by my predecessor, Sheldrake,* prior to the introduction of tenotomy. His apparatus consists of a padded metal shoe and lateral leg-splint, with a horizontal toe-spring. It is attached as follows—The deformed foot is carefully bound in the shoe-piece by strips of adhesive plaister, the next step being to secure the side splint to the outer side of the leg, in a similar manner, and the adducted foot is then finally drawn to the shoe. The mechanical action of this appliance is readily intelligible, for upon binding the foot within the shoe-piece, its lateral and inferior arches become extended by the pressure of the strapping on the dorsum of the foot, together with the counter-resistance of the calcis and metatarsus. When securing the side splint, care must be taken to give it a fulcrum against the metallic edge of the shoe-piece, as all chance of abrasion over the cuboid bone is thereby avoided, while at the same time the tendo-Achillis may be stretched by slightly varying its angle with the foot-piece. When, last of all, the lateral horizontal toe-spring is brought to bear upon the foot, it compels abduction and flexion, thus gradually restoring the foot to its normal condition.

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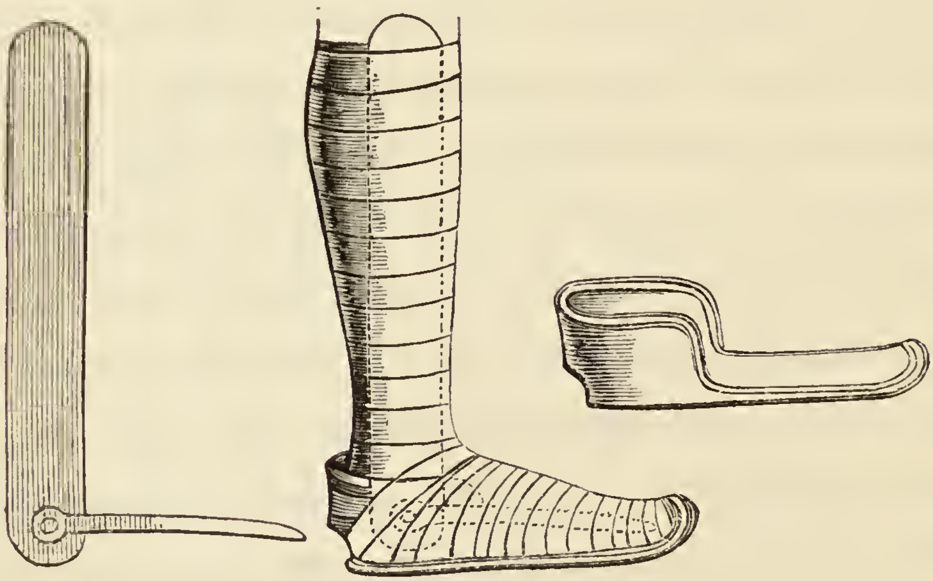
* The earliest English writer on the treatment of club-foot.

A small aperture is always left at the back of the heel-piece, in order to see that the heel is fairly down in its proper place.

Fig. 15.



Although this form of apparatus is now superseded by others of greater efficacy, yet it is without doubt safe and certain in attaining the desired object in those cases of infantile varus, to which tenotomy is, for some special reason, considered inapplicable.

In the earlier part of my career, and prior to the general adoption of tenotomy, I have frequently had as many as ten or twelve cases at a time wearing the simple shoe and adhesive plaister as devised by Mr. Sheldrake, and with scarcely any exception all these cases succeeded. The plaister was removed about once a week, the foot washed, a clean splint applied, and the foot rebound without giving the infant the least pain, neither was there any chance of abrasion, as but too frequently results, if the modern appliances are not very carefully watched and attended to.

The next kind of appliance used for slight varus consists of a series of padded tin shoes, the angles of which are raised in their degree as the cure progresses, until the foot has regained its perfect rectangular position in relation with the leg, and which are attached to the foot by adhesive straps, the mechanical object of the treatment being to gradually mould the foot into its true position.* A third, and highly ingenious appliance, is that termed "the Talipede,"* its object being to accommodate a shoe-piece to the malformity, by varying the movements of which, the foot would be ultimately restored to its pristine or straight condition. The three great desiderata, abduction, flexion, and retroversion, are obtained as follows:—Into the inferior surface of a metal shoe-piece (A), just below the heel, a circular piece of solid metal is riveted (C), which is in turn received into a steel socket (B); the latter being in connexion with a portion of the bar (*f*) which joins two lateral uprights (*d d*) (in which a leg splint, supporting the calf, terminates), by means of a small metal ring on the cylindrical surface of the bar, which, in addition to receiving the socket, is capable of being rotated on its own transverse axis. Thus, the fixing of the socket to the sole-piece allows the inner margin of the foot to be moved in a downward direction, abduction being facilitated by the manner in which the socket is received in the metal ring; whilst, finally, the cylindrical form of the connecting bar enables the ring to turn on its surface, by which means every advantage is afforded for obtaining the required amount of depression at the heel. In order that the foot may be maintained in the desired positions, each point of motion can be checked at will, by simply tightening a small thumb-screw, and in this way the foot may gradually be brought into a correct form, without the possibility of either patient or surgeon's being annoyed by pain, or abrasion of the cuticle, while the instrument is so simple that it is perfectly able to accommodate itself to any angles which the foot under treatment may have assumed. I entertain a very high opinion of this apparatus, believing that, for simplicity of construction and ease in

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* *Vide* Little, page 177.

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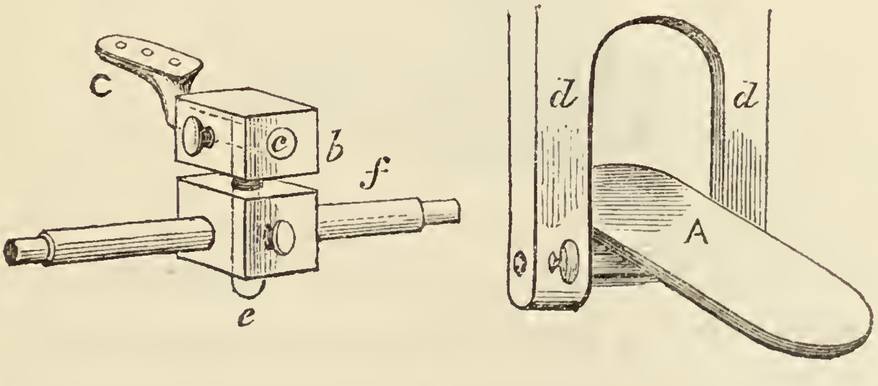
* I am indebted to Mr. Erichsen, for having kindly allowed me to inspect this instrument, which was invented by Mr. Aveling, of Sheffield.

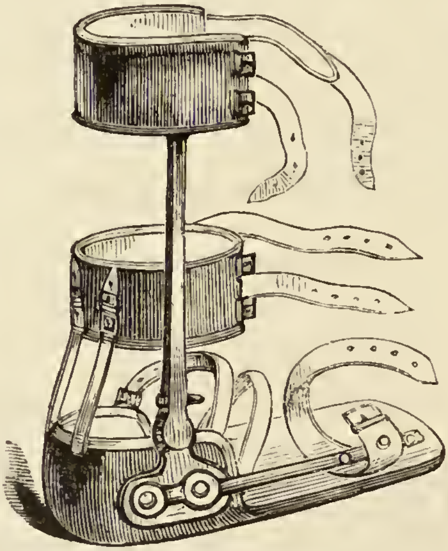
Fig. 16.



management, it is as good as any yet employed. It can be successfully applied to every condition of talipes: thus it is an approach to that perfect and universal combination of mechanical motion so much sought after in anatomical apparatuses.

I now come to that instrument which is more frequently employed than any other at the Royal Orthopædic Hospital. I allude to one consisting of a padded shoe, into which the foot is strapped; at the external margin of the shoe, close to the heel-piece, a perpendicular leg-stem is fixed, containing a rack-and-pinion joint, coincident with the ankle-joint. A metal stem passes along the external margin of the foot,

Fig. 17.



having at its extremity a rather broad strap, by which the toes are surrounded.

It is a modification of Scarpa's shoe, and is thus applied :—The ratchet-screw is first placed at such an angle as will allow the leg-stem and foot-piece to agree in direction with the corresponding parts in the deformed limb; the heel is then placed firmly in the recess intended for its reception, where it is secured by two padded straps, which pass over the instep. The ankle-band is now fastened round the leg, just above the malleoli, and beneath the perpendicular stem, thus forming a cylindrical strap, which restrains the heel so effectually that it cannot rise perpendicularly in the shoe, whilst at the same time it aids the two instep straps in obtaining a firm hold upon the foot. Proceeding with the adjustment, the toe-strap at the extremity of the horizontal stem is next passed around the toes, taking care to pass it round the toes only, so as to avoid falling into a blunder of occasional occurrence—viz., the passing it round the shoe-plate as well as the toes, a procedure which of course renders the action of this important power negative; finally, the operation is completed by fastening the calf-band, and thereby firmly attaching the entire apparatus to the leg.

To bring it into action, the toe-strap must be gradually tightened to remove the adduction, and the ankle-screw carefully turned until the heel is brought slightly downwards. By doing thus every two days for about six weeks, the foot can be gently brought into a normal form and position.

There is one very great objection to this modification of Scarpa's appliance, which is, that the fulcrum by which the tarsal arch is opened out, is obtained by pressure against the cuboid bone, the cuticle over which will, unless the most vigilant precautions are taken, most probably be abraded, an untoward event, which necessarily retards the progress of the cure for as long a period as the wound may choose to remain unhealed.

Dr. Langaard, the celebrated orthopædic mechanist of Hamburg, has invented the following instrument. An ordinary laced boot, stiffened on the inner side, especially at the heel, is fitted with a steel outside lateral stem, containing a rack and pinion centre just below the external malleolus, and two hinges (acting laterally), which are placed above it, at about two inches apart from each other. The upper end of this leg-stem terminates in a perforated lip. Thus much for the lower portion of the apparatus. The upper consists of a padded thigh-band and calf-trough, connected by an external stem, which is jointed at the knee. A perpendicular screw is fixed to the outer side of the calf-trough, the lower end of which enters the perforated lip, already alluded to as forming the upper end of the lower division of the apparatus. In this way the two portions become connected, while a clue is afforded for the explanation of the resultant action.

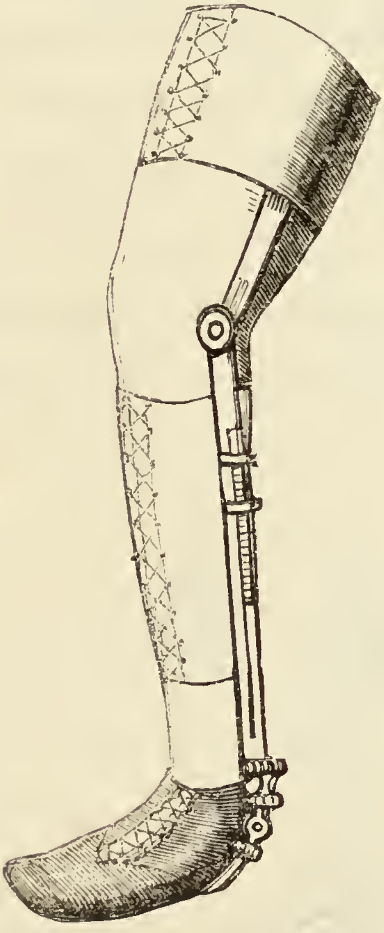
In applying this instrument, the foot must first be firmly laced within the boot, the calf and thigh troughs being then placed in their respective places on the leg, a position which, since the lower part of the apparatus is furnished with two lateral hinges, permits the external stem to conform itself readily to the arc which is formed by the tibial and cuboidal surfaces. The perpendicular screw is then gradually turned in such a direction as will induce an upward traction by the ankle-stem; the result of this being that, as the stem is fixed to the boot, and the boot to the foot, this screw-action exerts an immediate depressing influence upon the internal plantar margin of the foot, lessening the external arc of the malformity, by diminishing the length of the metallic superficies with which it is enveloped; the deformity is thus readily reduced to a condition of equinus. The rack-and-pinion centre, at first placed *beneath* the ankle-joint, but now brought up so as to coincide with its axis of motion, will enable the operator to elevate the foot, while he at the same time depresses the heel, and in this manner to restore the limb to a natural shape. Scientifically, it seems based upon the opinion held by some anatomists, that there is a mechanical centre at that point in the tarsus where the astragalus, calcaneus, cuboid, and navicular bones meet, and around which the anterior portion of the foot rotates longitudinally in the formation of varus. At first sight it would appear that the instrument must act upon all the limb which is situated below its tibial extremity, but as the astragalus is firmly locked within the trochlea formed by the ends of the tibia and fibula, the obliquity of the sole of the foot in varus, depends more probably upon lateral inversion, or adduction of the anterior two-thirds, accompanied by slight axial rotation. It is frequently suggested that obliquity of the plantar surface may be produced solely by the combined extending and adducting actions, without the least longitudinal rotation; the argument being, that the metatarsus is primarily oblique from the very shape of the individual component bones of the tarsus, with which it is articulated, and that during the formation of varus, the foot is at first extended, then drawn laterally inwards by muscular force, the metatarsus, in this latter process, simply moving in its plane of relation with the component bones of the tarsus, which, being originally oblique as compared with the horizontal axis of the malleolus, compels the foot to move in a latero-superior direction. The only theory opposed to this, mechanically speaking, is, that if the position of the metatarsus be held to account for the uplifting of the inner plantar margin in varus, how is it that lateral movement of the normal foot inwards does not induce uplifting of the plantar arch to a far greater extent than is actually produced? It must therefore be presumed that there *is* slight axial rotation between the scaphoid and astragalus during the formation of club-foot.

One great argument in favour of the rotative theory may be drawn from the frequency with which metatarsal obliquity is found remaining, after the equinus has been reduced, and the foot abducted to a considerable extent, the said obliquity necessitating the employment of powerful pressure upon the dorsal surface of the foot, before the malformity can be entirely removed. The apparatus used to effect this is, technically, called a "clamp," consisting simply of a strong piece of metal, which is arched over the instep, and fixed to the sole-plate of a Scarpa's shoe; a pad, governed by a perpendicular screw, being attached to its upper extremity. The firm and continued pressure of this will gradually depress and extend the plantar arches.

Although I have digressed from my description of Langaard's instrument, I have done so with the view of explaining the theoretical peculiarities of its action, and also of giving a slight sketch of the two more received opinions as to the causes of the foot's obliquity, apart from external agencies, in order that their merits may be brought to bear upon the claims of this instrument to rank with appliances of true scientific value.

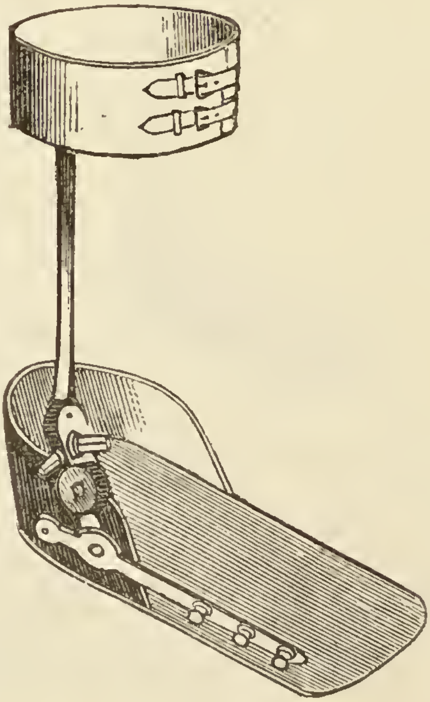
The following figure represents the apparatus:—

Fig. 18.



In severe cases of obliquity of the foot, another form of instrument is employed, having a rack-and-pinion joint, acting, at right angles, to that at the ankle-joint, fixed in the leg-stem, just above the external malleolus. Although intended to aid in overcoming the obliquity of the sole of the foot, it is nevertheless ill calculated for the furtherance of this object, in common with many other analogous instruments, because, upon bringing the lateral rack into action, a tendency to inversion of the upper border of the heel-piece, just below the external ankle, being at once set up, great pressure against the os calcis is produced, and this without the gain of any marked change for the better in the torsional uplifting of the inner border of the metatarsus (due, probably, to rotation at the astragalo-scaphoid

FIG. 19.



articulation). Nevertheless, there is this advantage about it, "that it enables the shoe-piece to be more accurately moulded to the foot than it could be in any other form of instrument," and since much of the plantar obliquity subsides when the anterior part of the foot is drawn outwards, we get a negative benefit from the circumstance that the rack-action just mentioned diminishes the pressure exerted by the heel-piece, while in action, against the external lateral surface of the heel and ankle—and *unequal* pressure is the chief point of complaint in *all* modifications of Scarpa's shoe.

I cannot omit the opportunity which here presents itself of attempting such an analysis of the various motions which arise during the progress of this deformity, from its earliest symptoms to the fully developed stage, as will, I think, lead to the recognition of a *general centre of distortion*, to which centre, also, the attempts at mechanical restoration should be directed. I wish, if possible, to determine the actual situation of that centre around which the osseous structures are grouped in equino-varus. The solution of this question has not, to my knowledge at least, hitherto been aimed at, although attempts have been made, successfully, to restore club-foot by an instrument, the mechanical action of which is based upon a theory, "that a transverse tibio-tarsal joint is formed during the progress of the malformity, and that, to ensure success, the treatment should consequently be divided into two stages, viz., one for the reduction of the varus, the other for that of the equinus." So generally has this theory been adopted, that it is customary, in cases which need operative assistance, to defer the section of the tendo Achillis until all lateral adduction has been removed by the division of the tibiales, antici et postici, and the foot has been mechanically abducted by means of a "Scarpa's" shoe. If, however, I am right in conjecturing that the one common centre of motion *can* be accurately determined, all necessity for dividing the treatment of club-foot into two stages is at once removed.

I have carefully prepared four diagrams, with the view of demonstrating those centres which are set up in the foot during the formation of equino-varus, and shall endeavour to show, by inference, how valuable an apparatus would be which should coincide in its arrangement with nature's law, and restore the foot to its pristine state by means of actions proceeding from one centre only. It must be remembered, though, that the axes of separate motions may be more or less approximated in various individuals; still, the establishment of the common centre is not in the least degree affected by this circumstance, it is simply necessary to make such allowances for trifling mathematical variations as each case may seem to demand.

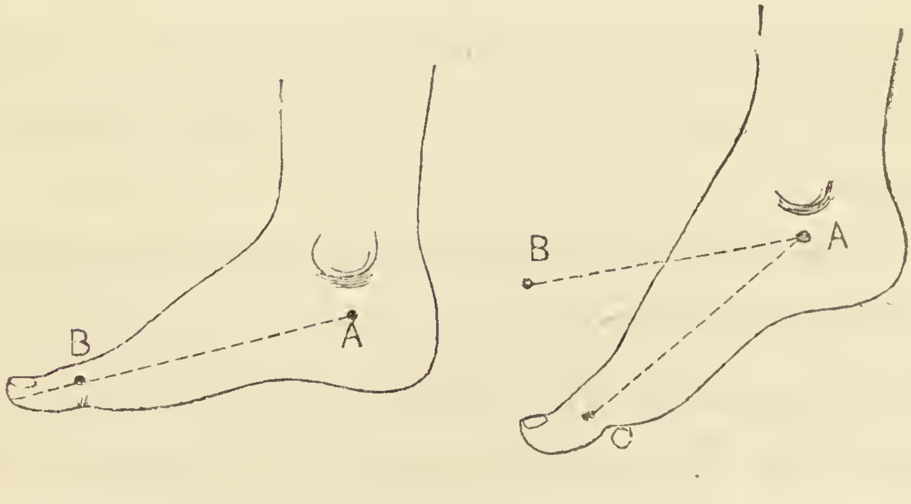
The formation of equino-varus being mainly referable to the contraction of those muscles which extend and adduct—viz., the tendo Achillis and tibiales, it is indisputable that these muscles must exercise their power around some special point, as otherwise they would mutually antagonize each other, and a deformity could not be set up.

On examining the direction assumed by the osseous structures of a severe case of club-foot, it will be found that, in addition to that self-evident centre, around which the foot moved during its extension and subsequent condition of equinus, there must have been another centre from which the displacement of the scaphoid, latero-superiorly around the articulating surface of the astragalus, proceeded.

When measuring the radii of motion, with a view of discovering where this axis lies, it is necessary to take some common point in the foot, sufficiently distant to be easily demonstrated in its relations with other centres, and yet so firmly established as to be but slightly influenced, as regards its distance from the assumed centre, by any positional change of the various bones included in the circumference of the circle in which the radients of motion lie. I have accordingly selected the metatarso-phalangeal joint, as a fixed point readily demonstrable in all stages of club-foot. Having taken this as a fixed point in the periphery of the circle formed by the radii of motion from the common centre, I beg to direct my reader's attention to the following diagrams, and at the same time to express my anxiety that they may be sufficiently explanatory of the views which I take of this question. Fig. 22 is to be considered as supplementary, and intended solely to elucidate the correspondence of the structural form of the foot with its mechanical motions, Fig. 23 determining the problem mathematically. I have given this supplementary diagram, because it is impossible to represent the different positions assumed by the foot in a single drawing.

In Fig. 20, intended to show the direction taken by the foot during the formation of equinus, let A be the malleolar axis, B the metatarso-phalangeal joint—which is simply selected as a point which bears relation, definitely, with the several centres in the foot. It will be seen that at whatever angle the foot may be extended upon the leg, the lines A B, A C, will be equal. That is to say, B and C are each points in the circumference of a circle

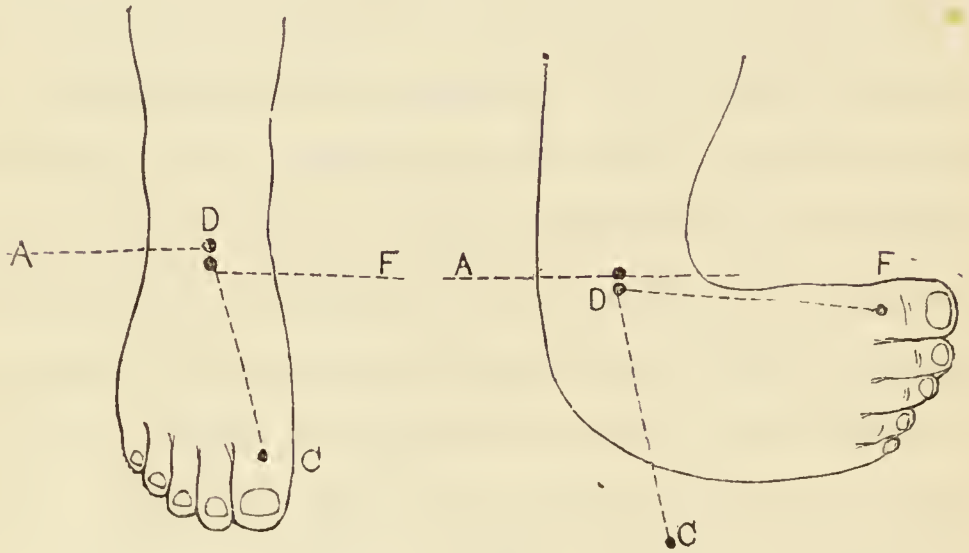
Fig. 20.



of which A is the centre, and therefore equidistant from A—ergo, A is the axis of motion.

In Fig. 21, which represents the direction assumed by the foot during the formation of varus, let D be the astragalo-scaphoid articulation, and C the metatarso-phalangeal, at whatever angle the foot may be abducted, the line D C shall be equal to the line D F—therefore D is the axis of motion in the formation of varus.

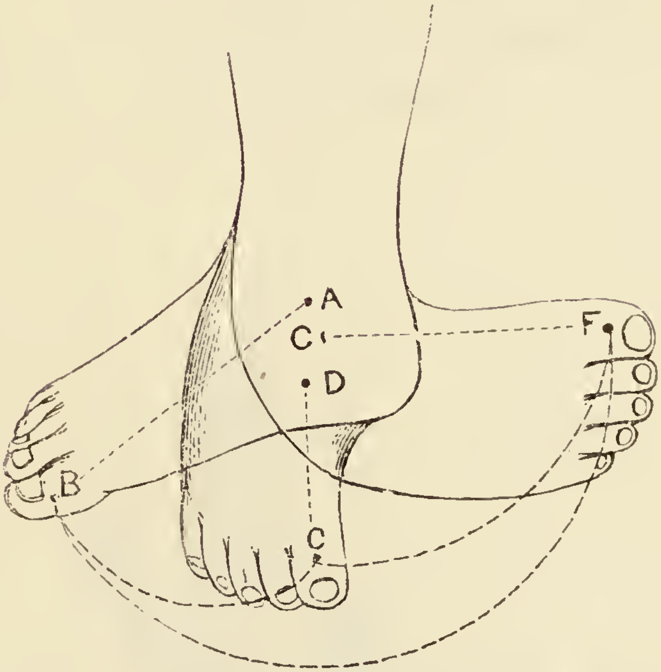
Fig. 21.



Thus, in the formation of equino-varus, the metatarso-phalangeal articulation passes by two distinct planes of motion, from B to C, and from C to F.

Now, instead of moving the point B, first to C, and then to F (as in Figs. 20 and 21), it can be made to move from B to F in a direct line, as may be seen in Fig. 22.

Fig. 22.

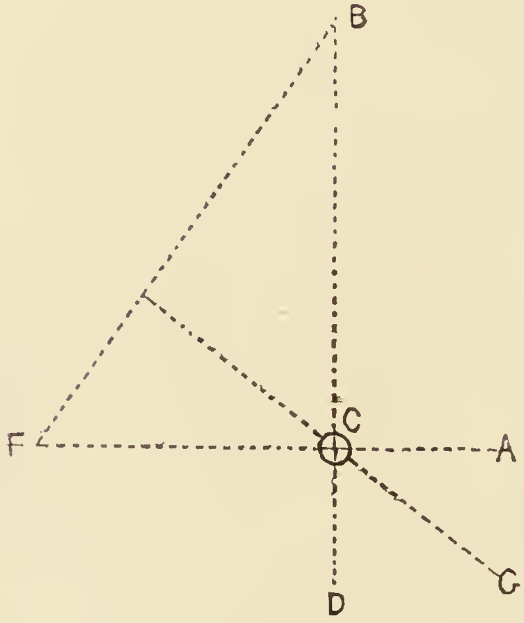


Let G be an established point between the centres AD, and equi-distant from each, so that G A shall equal G D; G will then partake of the character of both centres, and thus become the common axis around which B will move in its progress to F, and the arc B F will be the line of direction taken by B in its passage to F. This may be better understood by a reference to Fig. 23.

Let A F be the malleolar, and B D the

scaphoidal axis, F representing the metatarso-phalangeal articulation. Instead of moving

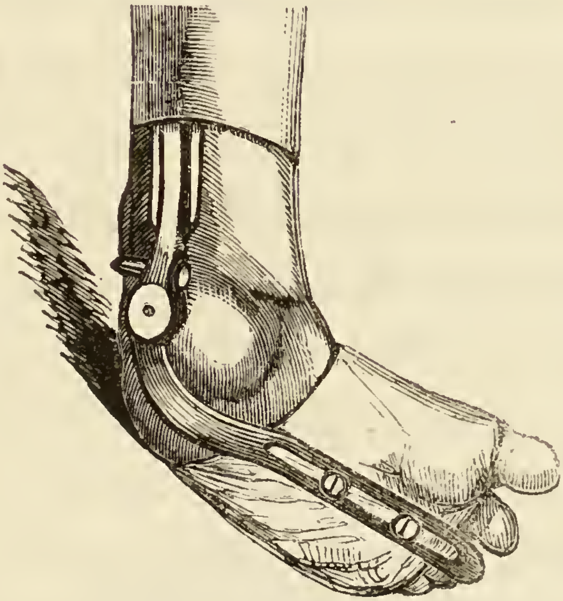
FIG. 23.



the point F first round the scaphoidal axis B D, through the plane A F, from F to C (at which point the foot would be in equinus), and then around the malleolar axis A F, through the plane B D, from C to B (when the foot would be brought to its normal position); instead, I say, of moving round these two axes, and through two distinct planes, first, from F to C, and then from C to B, the point adopted, F, could move round one axis G, placed at an angle of 45° to the two former, passing through one plane only from F to B.

It is therefore quite possible for an apparatus to be constructed which would, from one centre, restore an equino-varus to a normal condition. The annexed diagram gives an outline of its mechanical form.

FIG. 24.



It consists of a metal stem, furnished at the point which I have just laid down as being the common centre of movement with a rack-and-pinion joint, coincident in its plane with a line drawn from the great-toe joint of the deformity to the point which this articulation would occupy in the normal limb. The lower extremity of the leg-stem bears a padded metal plate, which embraces the metatarsus, and gives the mechanism control over the entire foot. Its upper extremity ends in calf and thigh bands, which secure the instrument firmly to the leg, while at the same time they afford a *point d'appui* for the action of the lower portion of it.

Upon moving the rack-and-pinion centre, the foot becomes gradually unfolded, and the necessity of dividing the mechanical treatment into two heads is thus done away with.

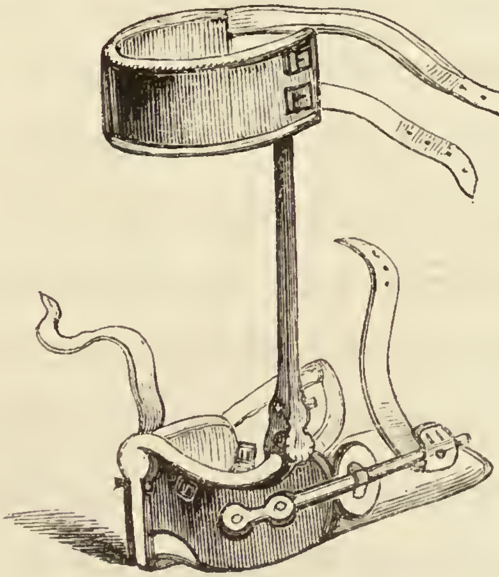
As the theory upon which this instrument acts is quite novel, I propose naming it the "Orthopæde," and trust that the principles of its operation may be found worthy of attention at the hands of the scientific reader, since it certainly lessens many of the mechanical difficulties met with in the treatment of equino-varus.

A very scientific and creditable instrument, intended for the reduction of "valgus," has been already described at page 35. I may here add that all ordinary cases of varus may be readily and successfully treated with it likewise.

Its merit consists in the adaptation of a rack-and-pinion axis at the back of the os calcis, which, by one and the same movement, induces depression of the internal plantar margin of the foot, with adduction of its anterior two-thirds. Another axis at the malleolus enables the heel to be brought down, and the equinus reduced. I need scarcely say that the only difference in the mode of its application, when adopted for varus or valgus, consists in the adapting the perpendicular leg-stem to the *outer side* of the limb for the former, the *inner* for the latter deformity.

For patients residing at a long distance from

FIG. 25.

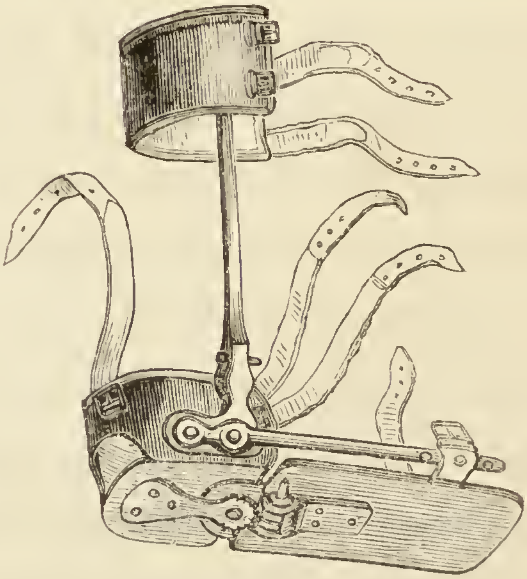


London, who cannot readily have alterations made in the mechanical construction of their apparatuses, this instrument is really invaluable, for it has the additional advantage of being very easily applied.

I give the same drawing here as at page 35, and it will be perceived that a small pad, which supports the tuberosity of the scaphoid in valgus, rests *here* upon the cuboid, and thus tends to expand the inner margin of the foot by pressing on the convexity, and expanding the extremities of the curve. Owing to the peculiarity of the action of the rack-and-pinion at the back of the heel, there is little cause for fearing any abrasion of the skin over the cuboid during the mechanical treatment.

Another description of appliance is constructed, by dividing the shoe-piece into two parts, and placing a ratchet-screw at the point of their junction (which is situated just below the point of convergence of the astragalus, calcaneus, cuboid, and scaphoid bones). By this arrangement an endeavour is made to obtain absolute control over the lateral motion of the anterior two-thirds of the foot, without subjecting the cuboid region to a painful degree of pressure, an untoward event which is occasionally a source of annoyance in cases of long standing, where the toe-strap and horizontal bar are employed in overcoming adduction, *without* the assistance of this division of the sole-piece. In order that the sole-plate may readily follow the direction assumed by the foot in its malformity, it will often be found advisable, when constructing this instrument, to add a rack-and-pinion joint to the toe-bar, just over the cuboid: by this means, the horizontal lever and sole-plate mutually contribute to perfecting each other's mechanical action. This apparatus is also furnished with a double rack-and-pinion leg-stem. On application, the division in the sole-plate, and the ratchet of the toe-bar, allow the instrument to be accurately adjusted to the shape of the foot. In order to bring it into action, it is necessary that the toe-bar rack be first moved in an outward direction, by which proceeding a tension *against* the plantar arch is obtained: the ratchet in the sole-plate is next so turned that the foot may be abducted, when, since the os calcis and astragalus are firmly held by the heel-socket of the shoe-piece, the scaphoid becomes gradually drawn outwards. This process entails a separation of the mechanical treatment into two distinct stages. In the *first*, which has just been described, we endeavour to reduce the foot into a state correspondent with that of simple equinus; and, where this has been accomplished, the second stage of treatment is commenced, by depressing the heel, which desideratum is brought about by the action of the two ratchet-screws at the malleoli, and, in this manner, by finally overcoming the obliquity of the sole of the foot, the patient's limb is restored to its proper condition.

FIG. 26.

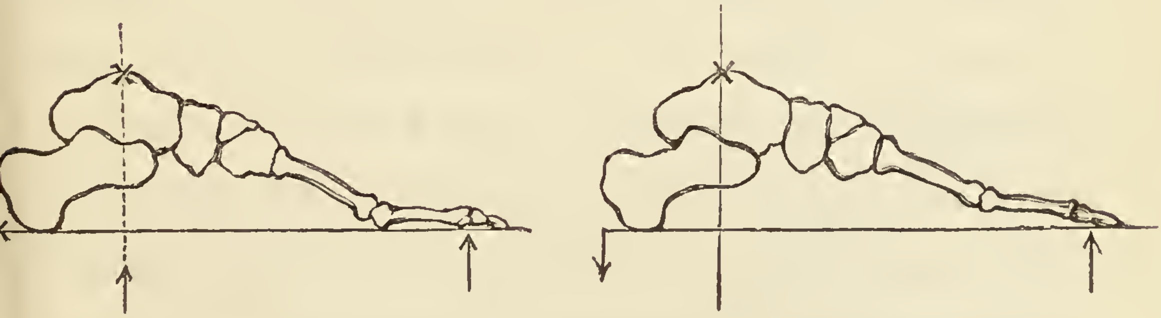


An instrument which is occasionally used at the Orthopædic Hospital, and called "Mr. Tamplin's shoe," is constructed as follows:—A metal splint, which receives the back of the leg, is prolonged as far as the extremities of the toes. Just under the heel, where the apparatus is rendered angular, for the accommodation of the foot, which is in a state of extension as regards the leg, a ratchet screw is attached, corresponding in the plane of its action, with the mesial line of the leg. A strip of metal, about the breadth of the fibular surface, and carrying at its inferior extremity a horizontal bar furnished with a toe-strap, is joined by a hinge to the external lateral margin of the leg-splint. Occasionally, the lateral surface of the splint is carried *above* the knee, being, in this case, furnished with a free joint coincident with that of the articulation. The entire apparatus is fixed to the leg by long straps of webbing, which pass through slits made in the metal splint.

When this contrivance is brought into action, the foot is abducted by the horizontal toe-bar, and an attempt made to change the angle formed by the foot with the leg, by so turning the ratchet screw, that the front of the leg and dorsum of the foot may be more nearly approximated. I believe, nay, I am sure, that this instrument is based upon erroneous principles, and upon these grounds :—The axis of motion around which the foot moves during the formation of equinus, is, indubitably, placed in the tibio-tarsal joint; consequently, the radius of deviation from the rectangular position comprehends, *anteriorly*, small portions of the os calcis and astragalus, together with the rest of the tarsus, and the entire metatarsus, whilst *posteriorly* it simply involves the remaining portions of the astragalus and calcaneus.

I need scarcely observe that the anterior radius moves in a downward, the posterior in an upward direction, thus forming segments of circles at their extremities, proportionate in area to the distance which intervenes between the centre of motion and the extremity of either radius. It may therefore be laid down as an axiom, "that no artificial centre which does not coincide with that demonstrated as the *natural one*, can possibly correspond with the mechanical position assumed by the foot in equino-varus." In the apparatus attributed to Mr. Tamplin, however, this artificial centre is placed immediately below the posterior margin of the os calcis; hence, *the whole of the foot* is embraced by the radius running from that point to the end of the toes, the said radius being represented by the action of the sole-plate. Now when the rack is turned, for the purpose of diminishing the inordinate extension of the foot upon the leg, the heel is positively uplifted, instead of being depressed. To show this the more clearly I have appended two diagrams, which will, I think, render the

FIG. 27.



error committed in the mechanical construction of this shoe tolerably intelligible.

The asterisks placed above the astragalus, are intended to represent the natural or true centre of motion; that at the heel, the one laid down by Mr. Tamplin. The arrows indicate the direction taken by the heel and toes.

It cannot even be urged in extenuation that the instep straps afford the necessary centre, as, from their attachment to the sole-plate, they are compelled to move with it in an upward direction. I do not imagine that this apparatus is often made use of, but, as it is "an invention," its claim to merit as a good instrument for the treatment of equino-varus may be fairly inquired into.

I take this opportunity of reiterating my convictions, that the treatment of this and other deformities can never be pursued with absolute success and certainty, unless the surgeon be aided, in the designing of his mechanical adjuncts, by scientific and well-educated mechanists. Apart from those difficulties which have been removed by tenotomy, the reason why so little progress was made in the treatment of deformities, when these cases were left almost entirely in the hands of the mechanist, will be found to consist in the fact that they were, with but few exceptions, mere "instrument makers," and not (as I firmly believe they ultimately will be) well acquainted with those mechanical laws on which the human body is constructed. It is not the object of this work to enter into a lengthened dissertation on the means which must be resorted to, ere the instrument makers can be rendered competent to intuitively understand the objects aimed at by the surgeon, in each stage of treatment of any deformity; but it is self-evident and incontrovertible, that the mere power of arranging mechanical appliances, so that they shall correspond with the external form of the deformity for which they are intended, cannot possibly entitle their constructor to that scientific position which he ought to hold in order that he may carry out the surgical desiderata of each case with absolute and practical certainty.

He need not be a profound anatomist, yet decidedly he should be tolerably well acquainted with the assumed positions of the centres of articulation in the various joints, and also with the forces which govern the movements of the human frame, under certain conditions; these things he can only learn by carefully studying osteology and myology in their relations to mechanical phenomena—theoretically by books, practically by frequently witnessing dissections. At the same time, there is no reason that the mechanist should ever be other than subordinate to the surgeon's directions; but, as the latter is necessarily a well-educated man, so ought the former to be possessed of such an amount of professional knowledge, as will place him in a position of sufficient importance in the scientific world to enable eminent surgeons to rely with confidence upon his eliminating their ideas in a practical form, and carrying them to a successful issue. I have always felt, from the first moment that I commenced my career, that a far greater and more varied amount of scientific information must be acquired by the mechanist (and so acquired, too, that it may be applied practically), before he can hope to be recognised in his proper and honourable position—viz., that of an educated and intelligent coadjutor to the surgeon, in rendering orthopædy worthy of ranking with the most important discoveries of modern surgical science; otherwise he is a mere handicraftsman—a "mechanic," not a "mechanist."

CHAPTER IV.

DEFORMITIES OF THE FOOT AND ANKLE.

TALIPES VARUS CONTINUED.

So various are the forms assumed by Talipes Varus, and so numerous the instruments employed in their treatment, that I am compelled to devote part of another chapter to the consideration and description of a limited number of the more important of them. I therefore proceed, without further digression, to resume the broken thread of my description.

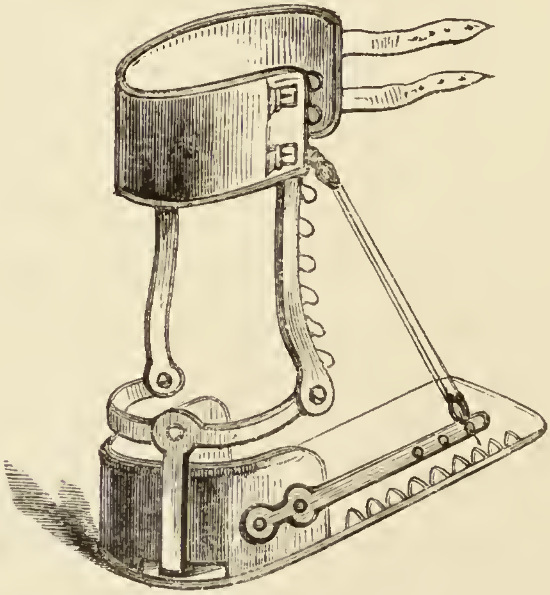
In the appliances previously noticed by me, the extending power has depended, in all, either upon the action of tangential screws, or of a powerful metal spring, or both. Still, it by no means follows, that other means are not equally available for the reduction of those abnormal positions which are assumed by the foot in this malformity. I have, for a long time past, *employed India-rubber cords for this purpose,* and consider that, if they are applied with care, their mode of action is far superior to that afforded by any other mechanical agent with which I am acquainted. So strongly impressed was I with the superiority of this material over others, when the idea first suggested itself to my mind, that I at once took out "Letters Patent," in order that I might have the sole privilege of attaching it to anatomical instruments. Since then I have frequently and successfully employed them in the treatment of deformities, both of the foot and the spine.

An excellent apparatus for varus, which acts by elastic force, is thus constructed:—An ordinary metal shoe-piece receives the foot, a small stem of metal, corresponding by a free joint with the longitudinal axis of the foot, being fixed to its posterior margin; this stem is joined at right angles by a curved metal bar, which extends from the inner to the outer ankle-joint. At each extremity of this bar, a free joint affords attachment to two leg-stems, joined at their upper ends by a calf-band.

Metal eyes are placed on the upper margin of these stems, for the reception of India-rubber cords.

On applying this instrument, the foot is first secured in its proper receptacle, by two straps which pass over the instep, while a third is fixed like a skate-strap, just over the astragalus. The toe-strap, belonging to the horizontal stem, is then drawn as tightly as possible, short of hurting the patient. An India-rubber cord is now extended from the outer leg-stem to the toe-bar, the resultant action being very singular, for, owing to the disposition of the posterior (calcial) and lateral (malleolar) centres, the external margin of the foot is uplifted, and the heel depressed, by one and the same elastic cord. The most prominent advantages accruing from this piece of mechanism are,—that the deformity is overcome by a power analogous to that which created it; and the maintenance of complete mobility of the foot throughout the whole period of treatment. The India-rubber cords can be increased in power to any extent which could be desired, by employing them of various sizes; and the elastic character of the resistance much diminishes the probability of abrasion being produced. Another good point about this instrument is, that the same apparatus is equally applicable to either varus, valgus, equinus, equino-varus, and calcaneus; as it is only necessary to vary the position of the cord, to obtain those particular mechanical actions, which may be desired for the removal of any one of these maladies. The only ground on which it is ever likely to be objected to is, that the elastic cord might elongate the tendons too rapidly; but this inconvenience can readily be obviated, by employing cords of a proper degree of strength—

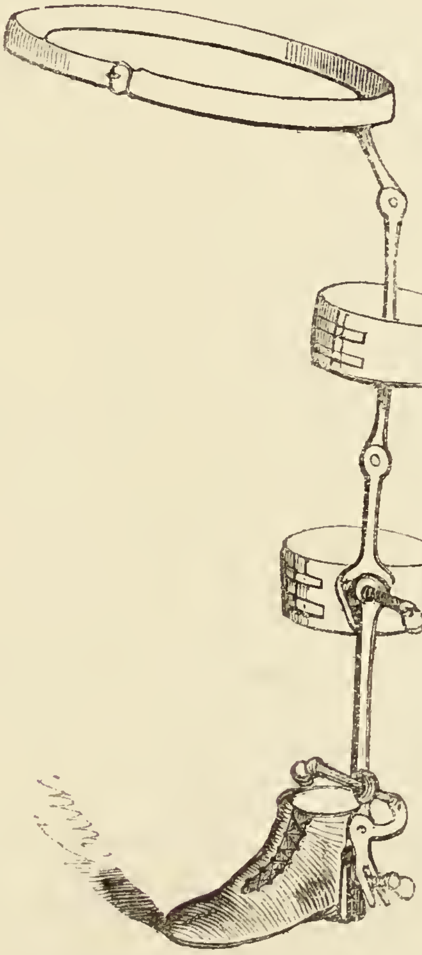
FIG. 28.



the age and condition of the patient being taken into consideration.

I now give another kind of apparatus, which will be found very efficient in many cases. The foot is received in a properly moulded metal shoe, on the external margin of which a stem, also of metal, is fixed, rising as high as the outer ankle, where it forms a lateral hinge with a steel leg-stem, which ascends the

Fig. 29.



leg as far as the middle of the thigh, being, moreover, made with a free joint at its point of coincidence with the knee.

This stem has also an ankle-joint, governed by a screw, which corresponds in action with that of the equinus. Just below the ankle-joint, and connected with the lateral hinge already mentioned, there is a small bifurcated downward prolongation from the leg-stem; the aperture, or slit, of which receives a pinion, forming by the shaft a worm, on which a nut of metal is screwed. Thus far the instrument is constructed with a view of overcoming the obliquity of the metatarsus. A horizontal screw is placed at the upper part of the leg-stem, just below the knee-joint, which, by acting against a small lip of steel, rotates the entire lower portion of the stem, and, of course, with it the shoe-piece. This movement is intended to counteract the adduction.

In employing this instrument, the foot must first of all be firmly fixed in the shoe part by straps; the next step being to secure the calf and thigh-bands. Then screw the nut upon the ankle pinion, in order that the sole of the foot may be everted: you may now turn the horizontal screw at the calf portion of the leg-stem, which has the effect of rotating the foot outwards, and bringing it into a condition of equinus. Lastly, flex the ankle ratchet, in order that you may uplift the anterior part of the foot, and restore the whole to a normal state.*

This apparatus is as simple in its mode of application, and as efficacious in active operation, as any with which I am acquainted; while, by its applying its rotative power in a line correspondent to the longitudinal axis of the leg, the cuboidal surface is exposed to a very slight amount of pressure—a matter of no slight importance in the management of mechanical appliances for Talipes Varus.

My next instrument (intended for adult varus) was suggested by Mr. Adams, who has already published an account of it.†

In construction it is based upon the principle of dividing the treatment of equino-varus into two distinct stages:—1. For the varus; 2. For the equinus; and likewise upon an assumption that there is a transverse joint in the tarsus, which separates the calcaneus and astragalus from the remaining bones of the foot. It is thus made :—To the leg a metal trough is adapted, jointed at the knee, and terminating in a lever, furnished with four rack-and-pinion centres, which lever extends as far as the end of the toes, where a metal plate slides upon it for the reception of the foot at the metatarso-phalangeal articulation; a triangular piece of metal likewise forming a rest for the heel. All these axes are so arranged, as to correspond with the various planes assumed by the foot in its abnormal condition, at points coincident with the centres of osseous displacement. Thus, the first joint, by being placed opposite to the cuboid, acquires a power of unfolding the foot in a downward direction, and is enabled, by exercising a leverage, to withdraw the navicular bone from its approximation to the inner malleolus; the second centre, which acts rectangularly to the first, uplifts the front of the foot; the third, perpendicular to the second in its action, depresses the inner margin of the metatarsus, and unfolds its transverse arch. By the combination of these three actions the foot is brought into a state of equinus; when the fourth centre, which is placed at a point exactly opposite to the malleolar axis, uplifts the foot, and depresses the heel, by a movement similar to that of the ordinary apparatus for equinus. In this instrument, there is an absence of pressure against the cuboidal region; the deformity of the foot being overcome by a counter resistance obtained from the fibular surface of the leg; for which reason the leg-trough should be thickly padded at this part.

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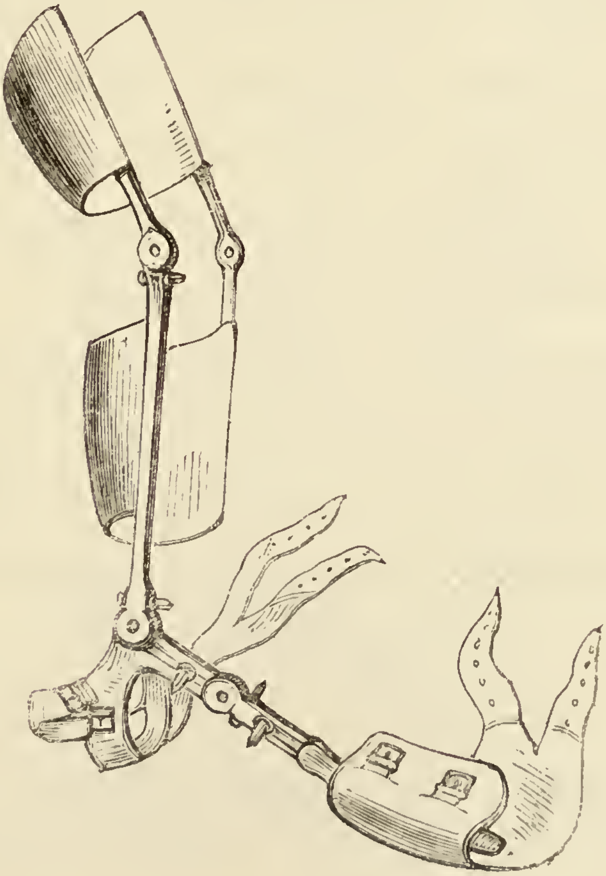
* This instrument was constructed at the suggestion of Mr. Le-Gros Clarke, and bears his name.

† *Vide* "Medical Times," Adams' Lectures.

Fig. 30.



The power of the instrument is very considerable, yet it can be regulated with the greatest delicacy, and there is no form of varus, however severe or complicated, which it cannot overcome, if used skilfully, and with a thorough knowledge of its practical details.

It is scarcely necessary to give a description of the various methods in which these four centres can be mechanically combined, since the purpose and form of the instrument has already been made public in a most able manner.

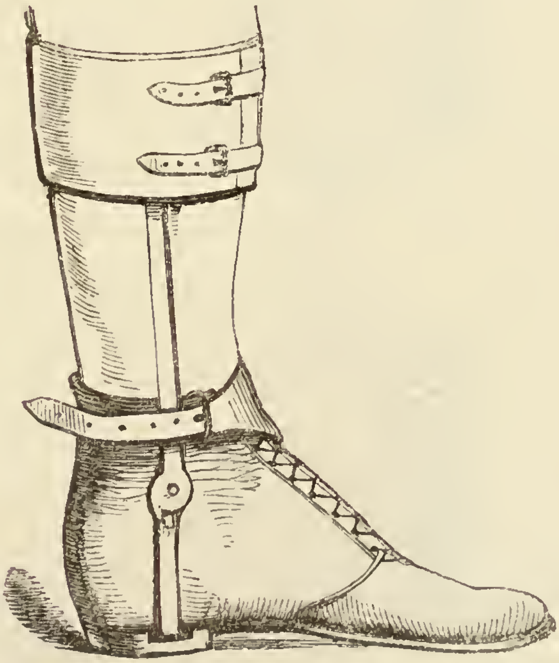
In addition to the instruments employed for the reduction of varus during its malformed condition, there are others intended only to restrain the limb in its corrected position, as also for adaptation in cases where there is simply a tendency to club-foot.

Of those which I shall here speak of, some are only intended for the purpose of exercising the limb, when the mechanical distortion has been remedied; others for cases where extension is combined with exercise. For the sake of convenience, these appliances have been divided into groups. In the first are placed the instruments which simply retain the foot in position; in the second, those which likewise extend and exercise the limb.

The simplest form of appliance for retention of the foot in infantile cases, is a padded splint, which is shaped to the tibial surface of the leg, and rendered rectangular at the shoe-part. When applied, it is bound on the leg by a few folds of an elastic roller. This splint can be worn by night as well as by day, as it is perforated, in order that the limb may be kept cool by the free admission of air.

The next retentive instrument for varus is composed of a metallic stem, passing as high

Fig. 31.

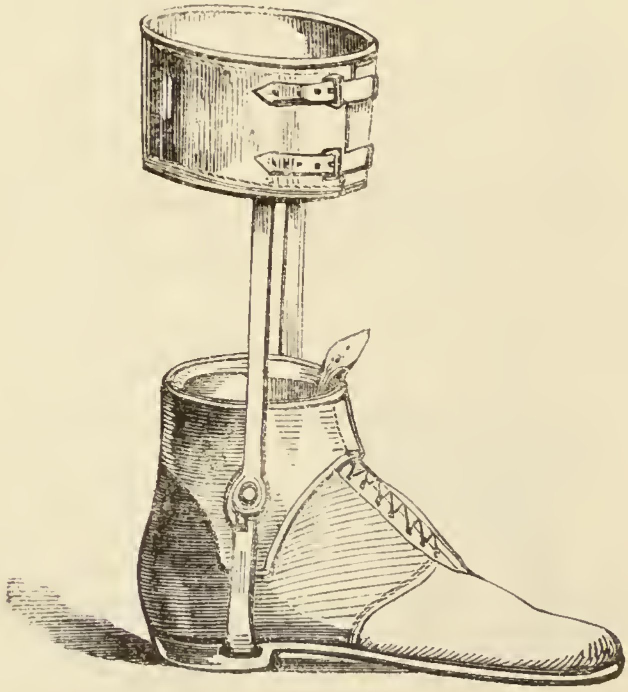


as the centre of the calf, on the tibial or *inner* surface of the leg. This stem is attached below to a stiffened laced-boot, and is furnished at the ankle with a stop-joint, *i.e.*, one that is limited in action to flexion of the foot upon the leg, by a metallic point, or spur. This is intended to prevent re-contraction of the tendo-Achillis, which might take place if a too ready extension were permitted.

The outer ankle is supported by a triangular strap, which preserves the foot in its corrected posture, by acting against the metallic stem.

Another appliance consists of two lateral stems, fixed to a calf-band, and furnished with

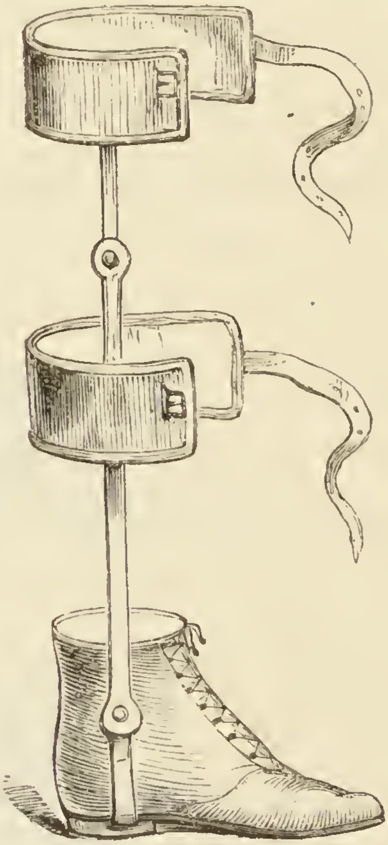
FIG. 32.



stop-ankle-joints; the object of which is to maintain the plantar surface of the foot in a horizontal position, especially where it manifests any tendency to obliquity. Since the two stems are fixed to a calf-band, they compel the bottom of the foot to remain at right angles with themselves; for it would be impossible for the sole to become oblique, without lessening the length of one of the perpendicular bars—and this cannot happen.

The next kind of apparatus is made by carrying a leg-stem as high as the middle of the thigh; joints being placed at the knee and ankle. It is customary to apply this instrument, either on the outer, or on the inner side of the leg. If the former plan be adopted, the boot is so arranged as to turn the toes out at a considerable angle; whilst the padding, lining the calf and thigh-bands, is composed of a material which will cling to the limb—thus preventing longitudinal rotation of the instrument around the leg. If the latter plan, the boot is, in like manner, rendered horizontally oblique, *outwardly;* and is also furnished with a very strong stiffener on the inner side, having a triangular strap which acts against it. By either method of application the desired end will be attained, if the instrument is carefully arranged. It therefore rests with the surgeon to adopt whichever plan he considers as likely to be most agreeable to the patient. It must, however, be confessed, "that if the tendency to inversion of the foot be *very considerable*, neither of these appliances will be found available."

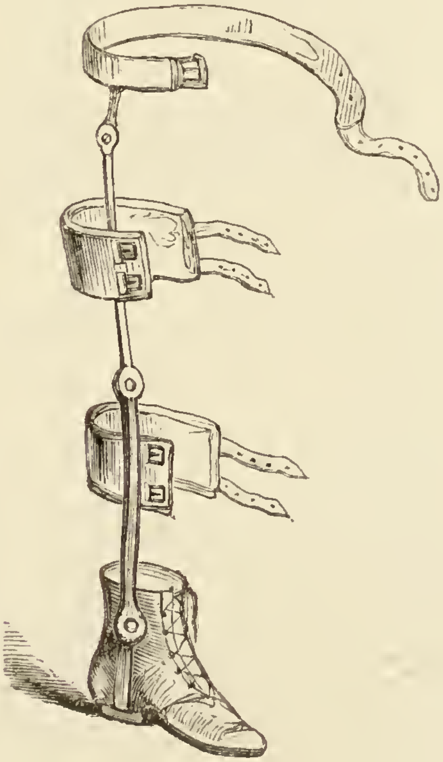
FIG. 33.



The best direction, mechanically speaking, that can be given for selecting the side on which the instrument should be applied, is, "that if the outer ankle has a tendency to eversion, the apparatus should invariably be applied to the inner side; should there, however, be no lateral deflexion, but simply a disposition for the foot to be adducted; it may be applied to either side indifferently."

Another appliance, constructed to prevent lateral inversion, consists of a perpendicular stem, worn on the outer side of the leg, and attached below to the boot; while above it ter-

FIG. 34.



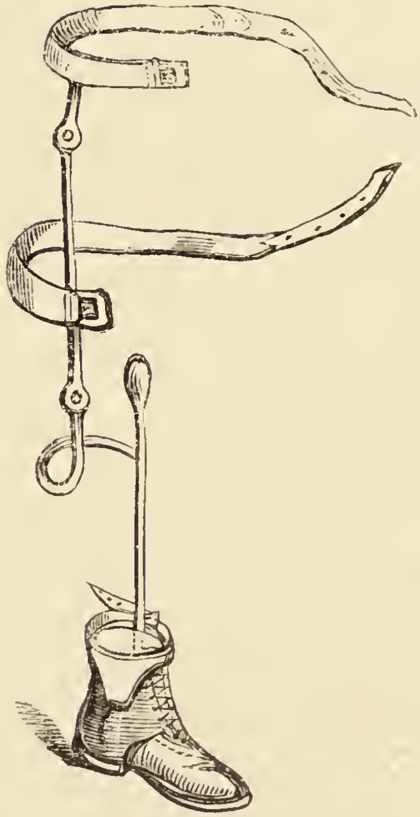
minates in a padded band, which surrounds the pelvis. Joints are placed at the ankle, knee, and hip, in order that the instrument may be freely flexed. The action is based upon an assumed principle, "That since the pelvic band is elliptical, it is hardly possible for it to turn cylindrically upon the body, however strongly it may be urged to do so by the tendency of the leg to inward rotation."

The perpendicular stem is thus maintained in the same plane as the mesial line of the body, the foot being held in a correct position, by the oblique *set* which is given to the plate by which it is secured to the instrument.

This instrument is sometimes modified by the addition of an inside stem. The object of which is, to keep the sole in a strictly horizontal plane, and likewise to admit of a triangular strap being fastened around the outer ankle.

Another apparatus has a perpendicular stem, reaching as high as the top of the calf on the inside of the leg; it is there joined by a transverse slip of steel, passing across at the back of the leg, and attaching another perpendicular stem on the outer side, which is jointed at the knee and hip, and screwed to a pelvic band. The only benefit gained by this arrangement is, that it requires less metal, and is consequently lighter than the one previously described: it also exercises a greater amount of rotative power upon the foot, owing to the mechanical forces being transmitted in a horizontal direction through the calf-bar; thereby securing the external obliquity of the foot.

Fig. 35.



A very excellent instrument is used for overcoming inversion of the foot in the French school of orthopædy. It consists of a metal stem, jointed at the knee and ankle, and fixed to a laced boot at the inferior extremity, the superior being attached to a padded metal pelvic band. The leg-stem is secured to the pelvic band by a perpendicular hinge, one side of which contains a small horizontal screw.* On turning this screw, the whole of the leg is rotated outwardly, thus compelling abduction of the toes, and at the same time effectually overcoming all tendency to inversion.

The same principle was carried out in England long ago; but instead of a screw at the waistband, we made use of a steel slide, governed by a buckle and strap at the back of the pelvis. By lessening the distance posteriorly between the metallic joints which correspond with the trochanteric axes, or hip-joints, the leg-stems are made to rotate slightly in an outward direction, and thence, by an action already explained, abduction of the foot is induced. To produce this effect, the patient is compelled to wear a perpendicular stem, &c., on each leg; whereas, by the French plan, one instrument answers the purpose quite as well as if two were used, as in the English method, thus giving a decided superiority to the French system.

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* Bonnet, "Traité de Thérapeutique des Maladies Articulaires," page 506. The engravings No. 36, 37, 38, are taken from Bonnet's work, as they serve to perfectly illustrate the best form of appliances for the purposes assigned them.

While concluding my description of the instruments used for retention, after the deformity (varus) has been ameliorated, I may as well mention one fact, which is, "that all the various appliances used in the mechanical treatment of varus in its original condition, are also capable of retaining the foot in position after the deformity has been reduced, if maintained on the limb for a sufficiently long period."

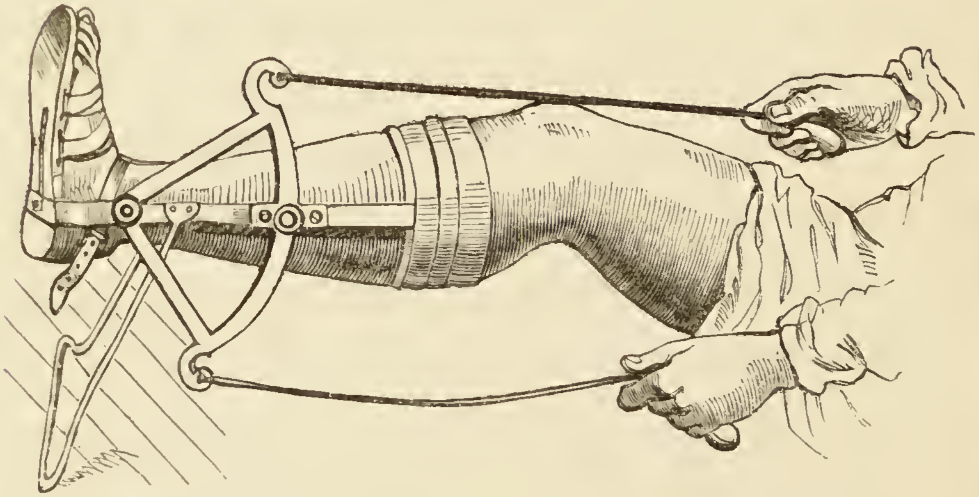
The second group of instruments are, as yet, but slightly employed in England, although they were shown to me when I was travelling over France, Germany, and many other parts of the Continent, as being invaluable so far as regarded their curative powers.

They are based upon a theory, "that the mobility of a contracted limb may be restored by mechanical exercise;" being unlike most other instruments adopted for the removal of deformity, in this respect, that whereas the latter act by slow and tedious stages, the appliances which I am about to describe perform their duty by vigorous, rapid, and often *sudden* movements. They commonly aim at one very important object, that of destroying the mechanical opposition to cure, which is caused by an undue tension of the tarsal ligaments; and they also tend to diminish any loss of mechanical power which may have befallen the muscles during the period in which their action was suspended. Manipulations, too (or movements with the hands), have long been considered valuable agents in obtaining free movement and muscular exercise; but as the direction and intensity of the force depends upon the skill and experience of the professional rubber, the results are not likely to be so satisfactory as when mechanical powers are substituted, the forces of which can be exactly estimated.

Thus, it is practicable to construct instruments intended for the purpose of exercising the foot with a graduated scale, so marked, that the patient may be enabled not only to comprehend the amount of motion bestowed, but even to co-operate actively with the wishes and intentions of his surgeon.

The first instrument which I shall describe, is intended for use in cases where, from the varus having been originally slight, the contractile tendency of the tendo-Achillis only has to be guarded against. Here the endeavour is to obtain flexion and extension at the ankle-joint. This is accomplished in the following manner:—An ordinary shoe-piece receives the foot, which it retains by means of two straps, passing over the instep. A metal stem with a free ankle-joint is attached to the outer margin of the shoe-piece, but instead of merely constructing this joint of two pieces of steel (about the size of a shilling), held together by a rivet in the centre in the ordinary manner, the lower part of the stem is expanded upwards in a fan-like form, and terminated at the periphery by two curved points, which receive the end of a cord. The upper part of the stem is secured to the leg by a padded calf-band; and in order to prevent uplifting of the whole leg, when power is applied to the ankle for the purposes of flexing and extending the foot, the calf-stem is usually fixed to a heavy piece of wood by a triangle of wire. The rope, or cord, proceeding from each end of the "fan-shaped ankle-joint," is held in the hands of the patient, who can readily produce a rapid motion, by pulling each cord alternately. If the periphery is marked by numbers, the amount of motion gained daily can be easily ascertained, as also the degrees of flexion and extension.

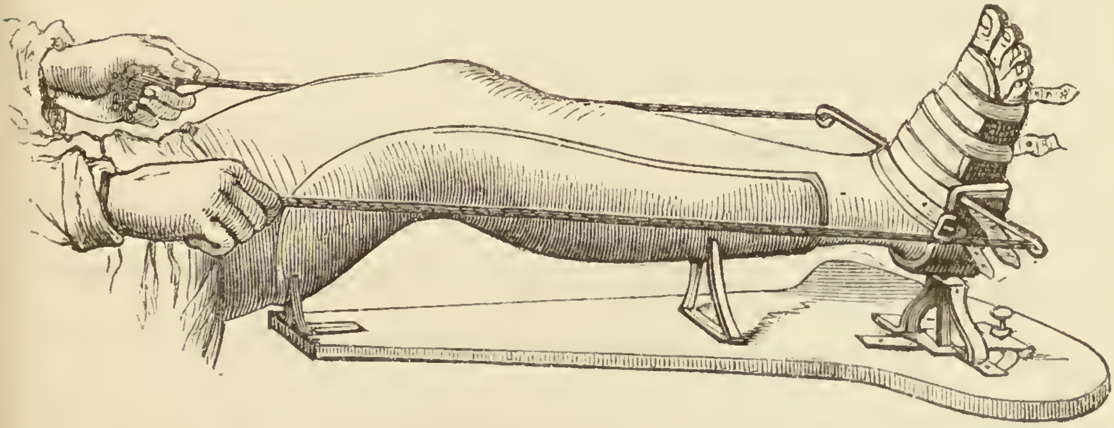
Fig. 36.



There is another very simple plan for accomplishing the same object, in which a strap sufficiently long to reach the hand is fixed to the toe of a leather boot, with another of like dimensions attached to the heel. The alternate action of these straps, combined with the resistance of the patient's body, enables the foot to be flexed and extended in a moderate ratio. The first apparatus, however, is by far the more efficacious of the two.

Where it is necessary to obtain reduction of the obliquity of the sole, as well as extension, a different instrument is recommended. This is constructed as follows:—A pivot-joint secured to a wooden frame, which extends as high as the middle of the thigh, and attaches a trough for the reception of the leg, is fixed to the posterior and external surface of the heel-piece of a padded shoe, in which the foot is secured by three straps passing over the dorsum of the foot with a thick pad of leather beneath them. On either side of the heel, a cord is attached to the margin of the shoe. When the patient

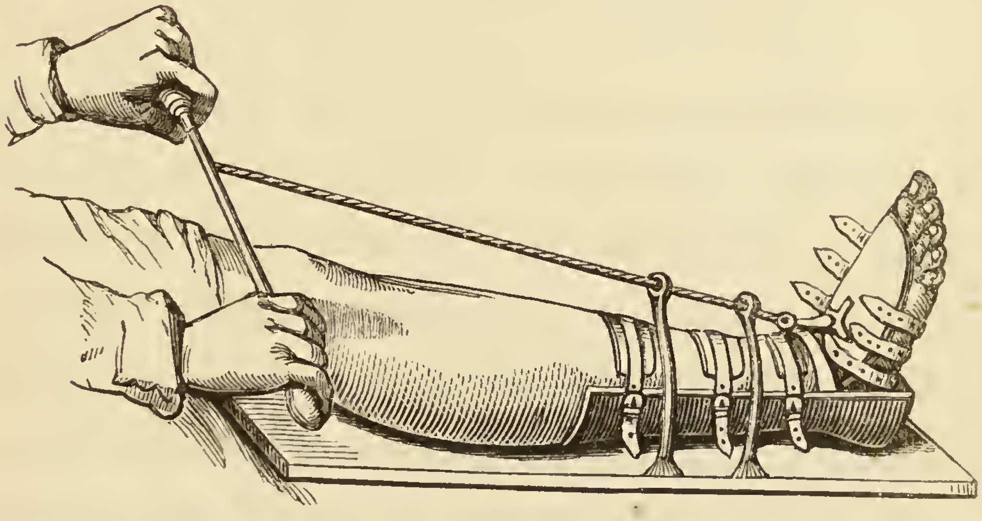
FIG. 37.



pulls these, a rocking motion is produced, which extends the external and internal margins of the sole, alternately.

A fourth instrument is made use of for the removal of any tendency the foot may show for "lateral adduction," this object being secured by placing it in a shoe-piece constructed with a dorsal pad, and connected with the leg by an ankle-trough, which is fixed to a wooden frame a little longer and broader than the leg itself. Two arches of steel spring from the outer edge of the frame, which are perforated by circular apertures at their upper ends. Through these openings a metal rod passes, furnished with a cross handle above, where it is within reach of the patient's hands, and terminated below by a triangular flange of metal, which forms a part of the dorsal pad. When this apparatus is applied with the view of being brought into action, the cross handle is moved upwards and downwards by the patient, the effect being to alternately adduct and abduct the sole of the foot by forces transmitted to the ankle through the metal rod. It is needless to observe, that since the tendency of the foot is mainly one of adduction, the greatest amount of speed is gained at that period of the motion in which the external side of the cross-handle is depressed. This exercise is particularly well calculated to expand the inner lateral arch of the foot; because, the heel being firmly held in the shoe-piece, and the axis of motion made to fall about the centre of the tarsus, a considerable strain is brought to bear upon the inner edge of the arch formed by the plantar fascia.

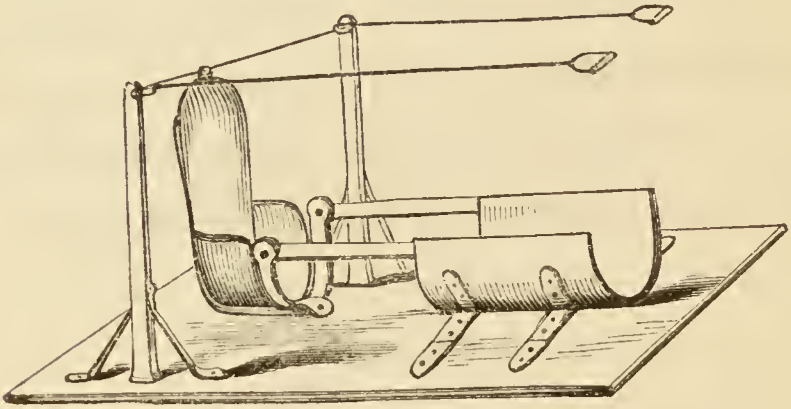
FIG. 38.



In these three motions is comprised all that is requisite for the correction of those elements which form the chief obstacles in the treatment of club-foot, viz., extension, inversion, and rotation; but it will be observed that for each motion a distinct apparatus is necessary.

This inconvenience may be obviated by making use of the annexed apparatus, which is arranged in such a manner that it admits of every variety of motion.

FIG. 39.

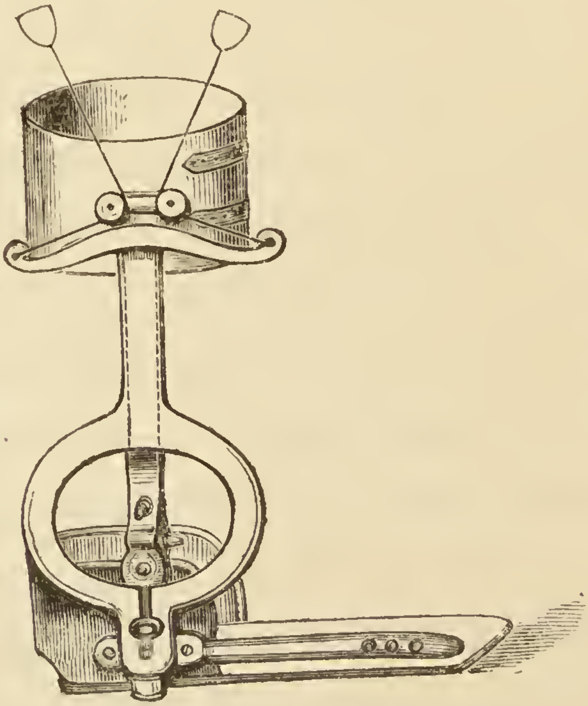


The foot is received by a metal shoe-piece, to which a stem is fixed at the posterior margin of the heel. This stem rises as high as the ankle-joint, and supports a small and almost horizontal steel curve, which extends to the outer and inner malleoli, where it becomes implicated in a joint belonging to the leg-stem. The stem itself terminates in a calf-band, which is fixed to a wooden frame by steel triangles. Two perpendicular rods furnished with pulleys are attached to that portion of the wooden frame which is opposite to the shoe-piece. Through these pulleys a cord passes, one end of which is secured to the toe-part of the apparatus, while the patient holds the other in his hand. When the cord is tightened, motion is first communicated to the shoe in a lateral and horizontal direction; but since the whole shoe rotates on the heel-centre, the lateral margin of the foot is uplifted at the same time, *i.e.*, it is drawn laterally outwards. As there is also a joint at the malleolar axis, the toe-part of the instrument is uplifted; thus all three motions, abduction, flexion, and extension, are *simultaneously* produced; a circumstance which gives the apparatus an advantage over all the Continental appliances of a like description. This instrument is an invention of my own.

In another appliance, the means employed for the cure of the deformity, and those taken to obtain exercise and retention in a normal position, are kept in a state of continued action. There is but one instrument of this kind, so far as I know, and that one I constructed for a patient who is under the care of Mr. W. Adams.

I proceeded as follows:—The single rack-and-pinion apparatus, described at Fig. 12, was so modified, that instead of the pinion being permanently fixed against the rack, as is customary in all contrivances of the kind, it was furnished with a "slot," which allowed the pinion to be thrown downwards, and, consequently, out of contact with the rack, whenever a small screw was loosened which held it to that part of the instrument. The lower ankle-stem had two steel pins rising from its surface, on which a lever, with cords at each extremity, could be instantly fitted, by simply turning a small nut. Thus, in a few seconds an ordinary varus apparatus can be rendered capable of receiving

Fig. 40.



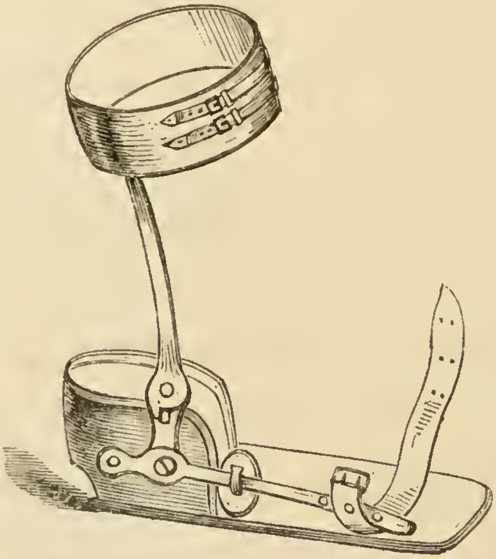
a rapid motion, by which flexion and extension will be produced.

I have now tersely sketched an outline of the instruments which are generally used in England for treating varus in its ordinary conditions and degrees of intensity; nevertheless, there is a variety which must not be suffered to pass unnoticed; more especially, since I have had frequent and unwonted opportunities of studying its characteristics within the last five years. I allude to that description of varus which is sometimes produced by gun-shot wounds.

The first case of the kind for which I had to construct an apparatus, was in that of an officer (a patient of Mr. Fergusson's), whose ankle was perforated by a rifle-ball in the Crimean campaign. The ball had been extracted, but owing to inflammation, which set in during the progress of reparation, the muscles became contracted to a considerable extent. At Mr. Fergusson's suggestion, I applied an apparatus which is here described, and with the happiest results. A padded shoe received the heel, on the external margin of which, and in a perpendicular line with the leg, was a spring lever, furnished with a stop at the ankle. Parallel with the metatarsus there was a spring, furnished with a webbing-strap, and fitted with a cuboidal pad, which said spring embraced the toes, the patient walking on crutches during the whole period of treatment.

The constant traction of the springs gradually overcame the inversion, and a boot, fitted with two lateral stems, and stop-ankle-joints, such as is described at Fig. 32, retained the foot in position, until all chance of contraction had passed away.

Fig. 41.



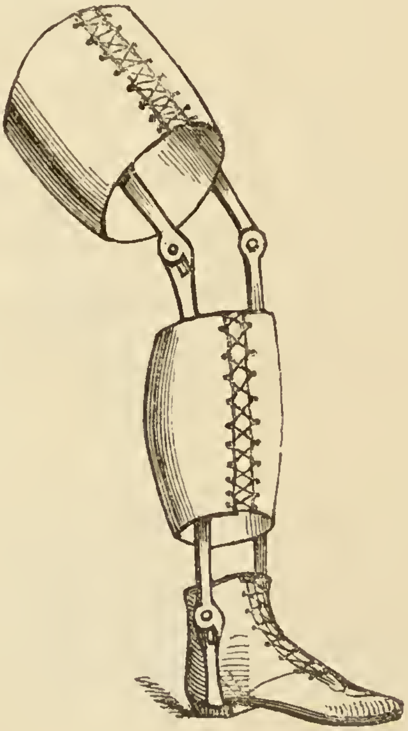
The second instrument I made for another officer, likewise under Mr. Fergusson's care.

Any pressure upon the front part of this gentleman's foot was productive of considerable pain, so that the surface upon which we ordinarily exercise power (the dorsum of the foot), was unable to afford leverage to an instrument. For this case I constructed an apparatus in which two lateral stems proceeded from a thigh-plate, articular centres being arranged in them at the knee and ankle, in such a way that the former joint was prevented from passing backwards out of the straight line, while another stop in the latter kept the shoe-plate from uprising beyond a rectangle with the leg. The foot was received in a stiffened boot, laced to the toes, the sole of which held the shoe-plate of the instrument. The inversion, in this case, was fortunately trifling, and mainly attributable to the ease experienced by the patient on placing his foot in a position of equino-varus.

This piece of mechanism produced very gratifying results when applied, for the patient could *then place* the whole of his bodily weight upon the instrument without painful pressure being made against the astragalus at the anterior part of the foot, which must have occurred had the joint at the ankle-piece been undefended by a mechanical stop. The power and habit of taking walking exercise effectually overcame all tendency to varus, as the pressure upon the toe-plate extended to the heel, until the foot and leg came to be at right angles, while the rest of the shoe-piece kept the foot constantly abducted.

The gentleman for whose use the apparatus was constructed could hardly bear the slightest weight to be rested on the foot at first, but, in the course of a few months, he was able to dispense with all mechanical support, and now

Fig. 42.



walks with as free a gait, and well-shaped a foot, as if nothing had happened.

During the war a large number of these cases passed through my hands, but as the features presented, by almost all of them, were of a similar character to those already described, viz., *positional* equino-varus, due to the condition under which the foot had been placed during the healing process, rarely accompanied by such an amount of contraction of the tendons as to need surgical division, it is unnecessary to say more concerning them, especially since by so doing I might incur the charge of attempting to extol my own merits.

The attentive observer will discover, that however much the various appliances which I have described as fitted for talipes varus may differ in external form, they nevertheless embody the same essential principles, both as regards their construction and mechanical actions. It will, therefore, undoubtedly be asked, what good can possibly arise from such extensive modifications in the arrangement of those conditions which are essential to the construction of a perfect instrument, that may be applicable in all cases, and which would only require to be varied in size to such an extent as might be necessary on account of the patient's age, &c.? In reply, I can only re-state that which I advanced at the commencement of the previous chapter, viz., that each individual case presents distinct difficulties, which necessitate, for their successful counteraction, variation in the mechanical forms of the remedial appliances used in each special instance.

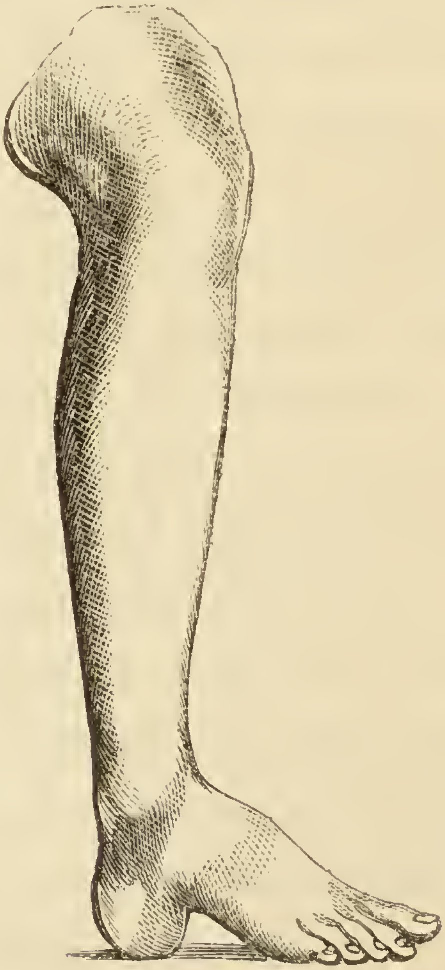
Thus, in all varieties of varus, the mechanical desiderata are abduction, eversion, and flexion. Any one who attempts to set straight a foot, which will yield to an application of force by the power of his hands, will discover that his first effort must be directed to a drawing downward and outward of the toes; his second, to rendering the plane of the sole horizontal by depressing its internal margin; and his third, to flexing the foot upon the leg. It may be held as an established rule, that every club-foot shoe must possess these several actions in the directions and sequence which I have here laid down. Much as the mechanical centres whence such motions originate call for thought and study, in order that the required result may be gained with the minimum expenditure of time and trouble, still, *in skilful hands*, almost any one out of the many instruments which I have described, will suffice for the reduction of the deformity and the straightening of the foot.

The surgeon should bear in mind one established axiom when he is selecting or advocating the use of any particular instrument, viz., "that in the hands of a bad workman the best tool is often useless, while a good one will often render a bad tool thoroughly capable of accomplishing the desired object, and this simply through superior skill," or, in the words of an old proverb, "A bad workman blames the tool."

It is the object of those who are compelled, by their special profession, to study and bring to perfection the scientific appliances which are required by the surgeon in the successful treatment of deformities, to simplify the difficulties attendant upon the manipulation of these appliances as much as possible; at the same time, however, bearing in mind those leading principles of action by which they must be governed when in use.

Since these laws are now well known, and their application in practice can be readily secured, there is no longer any reason why every surgeon should not possess a mechanical appliance so constructed as to be capable of affording any number of powers in any number of desired directions. By communicating with any one practically well versed in the principles upon which such instruments should be constructed, as well as in the mere details of handicraftship, the surgeon will discover that

Fig. 43.



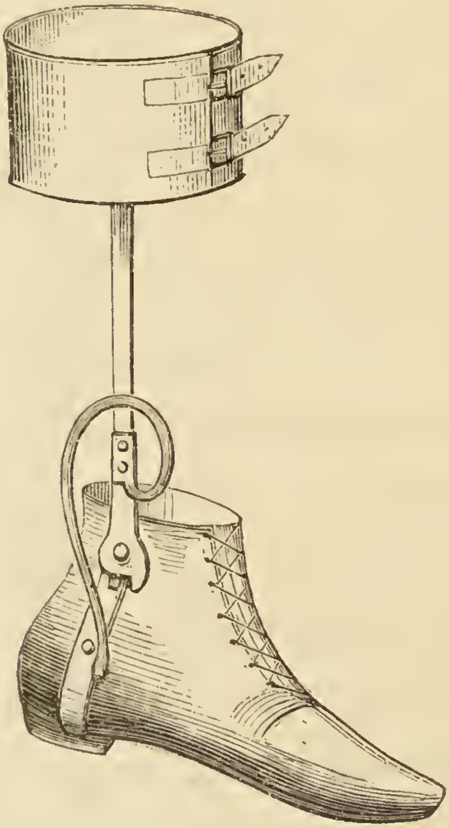
a correct treatment of the deformity will be very readily arrived at, by the combination of scientific surgical attainments on the part of the surgeon; mechanical, on that of the mechanist.

Prior to entirely closing the description of instruments employed for talipes, in its several forms of valgus, equinus, and varus, I must speak of those which are used for "Calcaneus."

A falling of the heel, and uplifting of the rest of the foot without much lateral distortion, are the distinguishing features of this deformity. The plantar-arch, too, is occasionally contracted, by which occurrence the metatarsal extremities and the os calcis will be approximated. In children, the foot is simply flexed to a greater angle than is ever assumed during exercise in a normal state; but in adults, in addition to the downfall of the calcaneus, and consequent lengthening of the tendo-Achillis, the sole of the foot is almost invariably contracted in its long axis. In slight cases, the following instrument is well calculated to bring about a mechanical restoration of the foot to its normal position and actions.

A metal stem, furnished with an ankle-joint, and bound to the leg by a calf-band, is fixed to the outer border of a padded shoe, in which the foot is received. A "vertical spring" is attached to this leg-stem, a little above the axis of the ankle-joint; the lower extremity of the said spring resting against a small steel pin, which is guarded by an ivory roller. By its pressure against this steel pin, the spring acts in such a manner as to induce a depression of the front part of the foot, with a con-

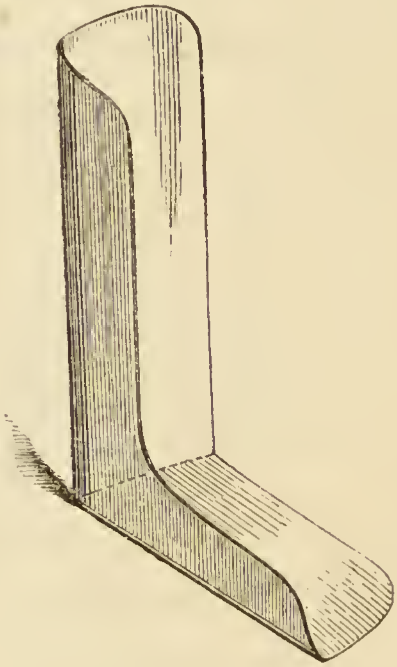
FIG. 44.



sequent diminution of the strain upon the tendo-Achillis. It likewise extends the muscles of the front of the leg—the peronei—enabling the patient to walk with greater ease and security, by replacing the leg upon its proper base of support.

When tenotomy has been previously performed, another apparatus may be adopted, which consists of a carefully moulded and well padded back splint (leg), made of metal, with a sole-piece at the lower end, set at an angle of a rather greater degree than a right angle, the object of this being that the front of the foot may be brought downwards, the heel, meanwhile, being supported by a very soft pad, which should be placed beneath it at the point of junction of the foot and leg plates. This splint may be kept in place either by adhesive *strapping*, or bands of webbing; the former, however, being preferable, because the foot acquires a tendency to draw the splint perpendicularly downwards from a leverage which is exercised by the front of the foot in an upward direction, consequently thereby transferring force to the calcaneus, which, by acting as a fulcrum, aids in bringing about a displacement of the leg splint, unless the splint be so firmly bound on that it cannot be moved, and this requisite can only be secured by a judicious application of adhesive strapping.

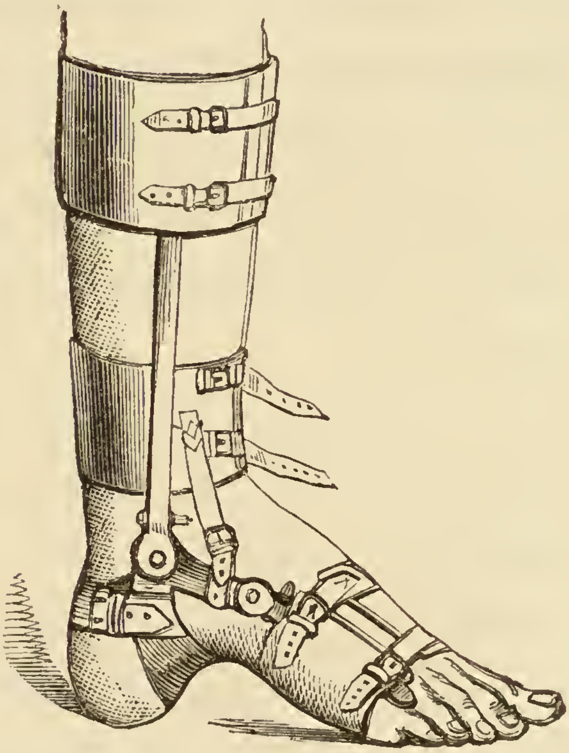
Fig. 45.



An apparatus which I have recently invented is likely to be of much service in cases of great severity. It is made as follows, and, I must premise, especially directs its powers to the acquisition of an extension of the plantar arch, uplifting of the toes, and a throwing of the prominent calcaneus backwards and upwards, by using it as a fulcrum.

In the lower extremity of a perpendicular stem, which passes down the leg on its outer side, and in coincidence with the malleolar

Fig. 46.



axis, a rack-and-pinion centre is attached, from which there proceeds a small arm of metal, supporting a plate which is accurately moulded to the anterior surface of the calcaneus. Since it is the radius of a circle, formed by the malleolar axis as a centre, with the extremity of the calcaneus as a point in the circumference, this arm necessarily moves backwards and upwards. Another stem, which is carried to the extremity of the metatarsus, and bears a plate into which the plantar surface of the metatarsus and the proximate phalanges of the toes are received, is placed towards the front of the ankle-rack. Finally, another rack-and-pinion centre is established in the foot-stem, just opposite to the calcaneo-cuboid articulation, which uplifts the anterior part of the foot by its action; for the stem becomes a radius to a circle which involves the anterior two-thirds of the foot.

By these two movements the plantar arch is gradually expanded, and the foot restored to its natural condition. I feel assured that this apparatus would conquer calcaneus of any degree of severity, no matter how great; taking it for granted that in this, as in *all* other forms of club-foot, tenotomy had been performed by the surgeon prior to the application of an apparatus.

With this instrument I shall conclude that portion of my work which is devoted to the description of such appliances as are used in the treatment and cure of deformities of the foot; for, although I am familiar with several varieties of *secondary distortion*, resulting from a combination of two or more kinds of *pri-*

mary deformity, e.g., equino-valgus, equino-varus, calcaneo-valgus, calcaneo-varus, yet I am equally well aware that all the appliances which are constructed for the treatment of the primary deformities may be employed with a certainty of success in those cases where the displacement has been so considerable, and continued for such a length of time, that some one or other of these secondary abnormalities has been superinduced.

CHAPTER V.

DEFORMITIES OF THE LEG, KNEE, AND HIP.

The term "bowed" or "bandied" legs is so thoroughly familiar to all, that I must appear to be guilty of effrontery in attempting to describe the external characteristics of such a common and "every-day" deformity. Unimportant, however, as it would at first sight appear, and spite of the well-known ease with which it may be remedied, if taken in time, few distortions are more worthy of attention at the hands of those who are professionally compelled to consider what influences the mechanical conditions of one class of deformities will be likely to exert in the production of others. Thus, an excurvation of the tibia may, if neglected, lead to a loosening of the ligamentous attachments of the knee-joint, disturbance of the functions of the hip-joint, or even deflection of the spinal column.*

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* *Vide* Bishop on Deformities, page 247.

The direction assumed by a curvature of the tibia may be lateral, anterior, or a combination of both of these; and it not unfrequently happens that a simple instance of either of the two former conditions is converted into a severe one of the latter, simply through a neglect of the most ordinary mechanical precautions.

Although the presumed *physiological* causes of "bowed legs" are foreign to the subject of this work, yet it is necessary that I should inform my lay readers that this deformity is primarily due to a softening of the bones, the result of a change in the chemical proportions of the component ingredients of the osseous structures (diminution of the earthy matters). The deformity is mainly referable to the mechanical results brought about by this softened condition of the bones—the legs being unable to bear the weight of the body, when unaided by artificial assistance. When this extraneous help is withheld, the bones become curved on their long axes; therefore, all mechanical treatment should aim, firstly, at supplying the needed solidity; secondly, at restoring the arched bone to its pristine straight condition.

There are two principles upon which this is sought to be accomplished—one calls for an extension of the extremities of the curve, and depression of its arc, by supplying an artificial base, and gradually *inducing* the leg so as to become parallel with it; the other, for an application of a straight line to the vertex, or highest point of the arc, and a drawing of the extremities towards the line until the limb has been brought into a normal shape.* The latter plan is very rarely followed—in fact, it is very dubious whether it can ever have succeeded. Firstly, because it is extremely difficult to keep any straight surface applied to the vertex of the curve; secondly, because it is almost certain that such a mode of treatment, if attempted, would be defeated by the production of abrasions. The methods generally pursued in the mechanical treatment of these deformities are therefore in conformity with the former of these two principles, and the instruments are for this reason constructed as follows:—The simplest consists of a padded piece of wood, placed on the inner side of the leg, and extending from the internal malleolus to a point just above the internal femoral condyle; it is therefore *a base* opposed to the convexity of the curve. To render the limb amenable to its powers, a long strap of webbing is passed several times round the leg, so as to embrace both splint and tibia, which tends to diminish the arc of curvature by resistance, and consequent longitudinal expansion at its extremities, together with diminution of its transverse axis.

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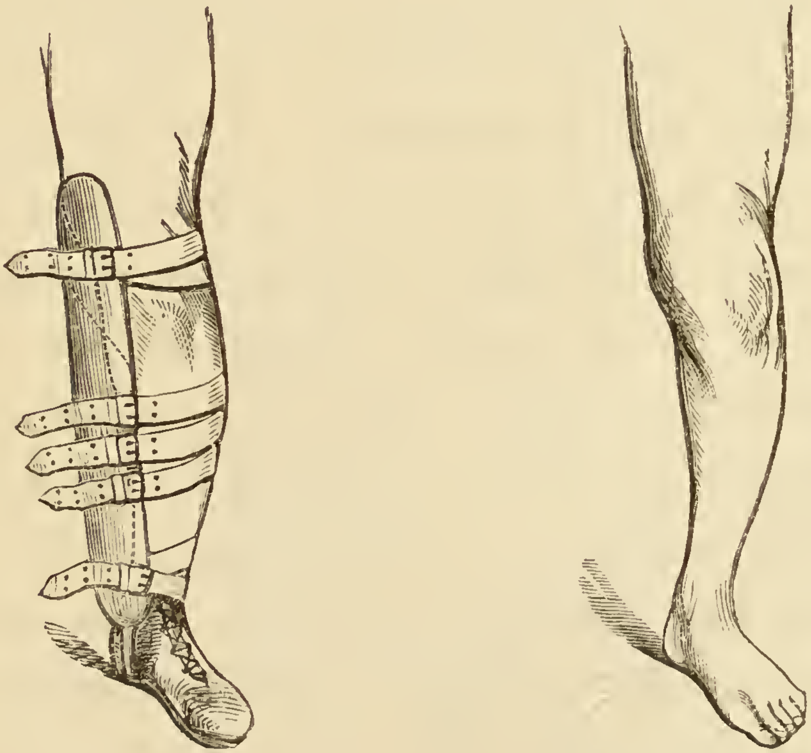
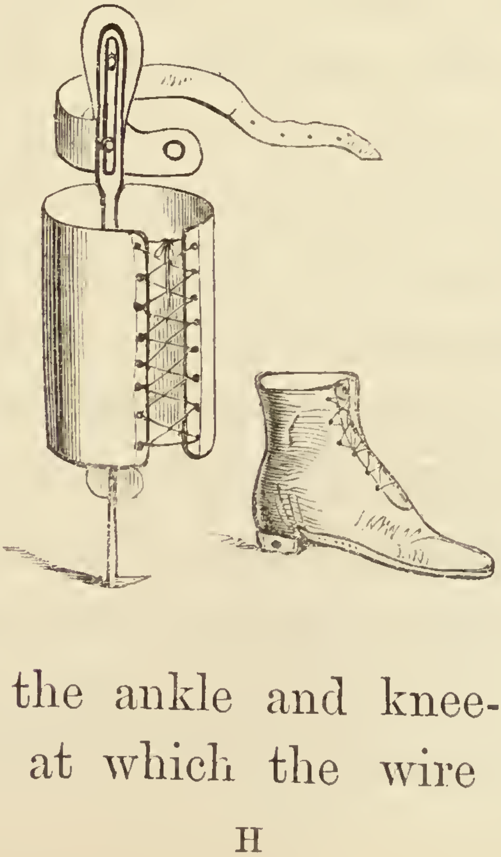
* *Vide* Little, page 32.

Fig. 47.



This splint is imperfect in action unless secured to the heel of the patient's foot by a metal socket, which has the effect of preventing cylindrical rotation of the splint round the leg —a thing which will happen in spite of the greatest care, unless the boot and splint are mutually connected. For this purpose, a small piece of metal is fixed to the lower edge of the splint, which is inserted by a tubular socket into the heel of the boot. When the case for treatment is but a slight one, the simple apparatus just described will do all that is required; but if anterior yielding is superadded to lateral deflection, a more complex apparatus will be requisite. For this purpose I usually recommend an instrument which is composed of a slight steel stem, attached to the boot by a tubular socket, at the upper extremity of which there is a padded plate receiving the resistance offered by the head of the tibia, whilst a small cushion, which rests against the internal malleolus, gives a *point d'appui* to the lower end of the curve. A piece of bent wire, conformed to the quadrilateral outline of the back part of the leg, is attached to the leg-stem at its posterior margin. The whole is completed by a strong leathern bandage, which, starting from the leg-stem, passes around the back part of the instrument over the arc of curvature, when it again rejoins the stem, thus obtaining a circular grasp of the leg. The leathern bandage is closed by a long lace. The action of this apparatus is peculiar: as there are two distinct planes of curvature—one lateral, the other anterior—it is important that both should be acted upon simultaneously; and this postulate is accomplished in the following manner.—The extremities of the lateral curves are opposed by the ankle and knee-pads, whilst the distance at which the wire calf-piece is

FIG. 48.

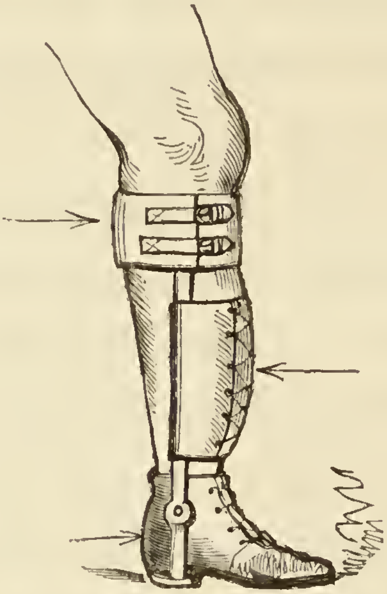


placed from the posterior surface of the leg, necessarily involves a pressure of the anterior arc backwards the instant that the leathern bandage becomes tightened. So effective is this form of instrument, that you may even see the arcs of curvature diminishing as the lacing becomes tightened; evidence of this being afforded by the diminution in space between the lateral leg-stem and the posterior calf-piece.

Sometimes, however, the anterior curvature will be so excessive as to defy all attempts at overcoming the distortion by means of this apparatus. In such case, the instrument just described must be modified by the substitution of a thin metal trough, perforated by four slits, in lieu of the wire calf-piece. Through these apertures, two webbing straps pass, one above the vertex of the anterior curvature, the other below it; and, as they are attached to the troughs by buckles and straps, they act directly backwards. A small stop-joint is arranged opposite to the internal malleolus, which prevents the unnatural up-lifting of the toes, otherwise likely to be produced by the exercise of pressure against the front of the tibia. Instead of fitting into a tubular socket, in the heel, the leg-stem is firmly attached to the boot. When this instrument is applied, the two straps and laced leathern bandage are tightened, the former producing pressure against the anterior, the latter against the lateral arc, whilst the metal side-stem supplies a base, at the same time strengthening and attaching the whole.

There is another description of appliance which I have made use of in cases of severe anterior curvature, unaccompanied by much lateral deflection. It is composed of two perpendicular stems, jointed opposite to the ankle, and furnished with a *lacing* leathern band which passes across the front of the leg, and is then reflected back again around the lateral stems. The leg-stems terminate above by a metal band which joins them posteriorly, and below is a laced boot. On application, and tightening of the leathern bandage, the head of the tibia receives the pressure of the upper metal band at its posterior surface, while the heel of the boot serves for a second point of resistance, so that the more the laced band is tightened over the arc of curvature, the greater will be the depression of its transverse axis, with a corresponding expansion at the extremities; the former force being exercised in a posterior, the latter in an anterior direction, thus gradually unfolding the curvature.

FIG. 49.



As every kind of tibial malformity may be successfully treated with these appliances, there cannot be the slightest necessity for my describing many others, which are mere modifications in structure of one or the other of the plans just detailed.

The next distortion affecting the lower extremity which is capable of entire removal by mechanical aid, is known as "lateral yielding of the knee-joint, with approximation of the two internal condyles of the femur,"—vulgo, "knock-knees."

This deformity is primarily referable to a relaxation of the internal lateral ligaments, which, by permitting the superior and inferior extremities of the tibia and femur respectively to become slightly separated at their internal lateral surface, disturbs the axis of the joint (nearly horizontal), and creates an angular obliquity of the component bones. This angular condition is very greatly increased by the superincumbent weight of the body. The object, therefore, which is most aimed at in the construction of every variety of apparatus intended for the treatment of this distortion, is the restoration of the leg and thigh to a vertical position by bringing the knee-joint into its original condition.

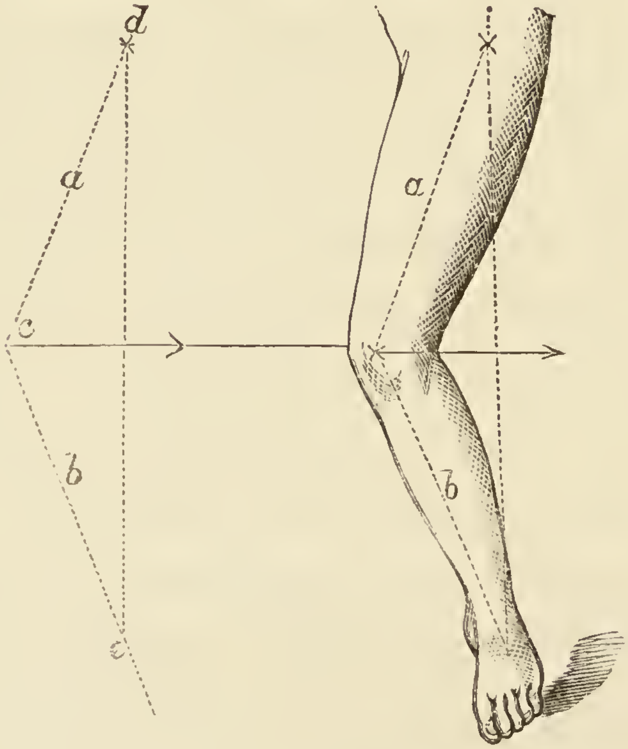
The mode of accomplishment is by no means so simple as would at first sight be supposed, and for the following reasons. The deformity involves a disturbance of the normal perpendicular position of the entire leg, resolving it into an angle composed of two levers. The first and shortest of these, the thigh, is joined to the pelvis, its centre of radiation; the second, the leg, apparently radiates from the knee-joint, although, as I shall presently demonstrate, it deflects from a different point.

In order that the apparatus may act upon the knee-joint with the greatest possible economy of force, one extremity must be attached to the pelvis, the other to the heel of the boot. Taking these two points, then, as the centres of circles, which *cut* one another at the centre of motion in the knee-joint in "genu-valgum," but only *touch* at this point in the normal state of the limb, from which the thigh and leg respectively are as distinct radii to these points in their peripheries; it is manifest that when these radii, or levers, are not in the same perpendicular straight line, as is the case in the distortion under discussion, the centres of the circles must be brought nearer to one another, so that the line joining them would be as the base of a triangle. Now by applying power to the inner surface of the knee, the apex of the angle formed by the thigh and leg, we compel these radii to move in an outward direction, lengthening the base of the triangle, and increasing the distance between the centres of the two circles; *finally, bringing the radii into such a position, that their centres of rotation, and the levers themselves,* *shall have become coincident in one and the same straight line.*

Unphilosophically viewed, it would appear, from the great distance intervening between the two feet, that the end of the femur must become a fixed point of rotation for the tibia; but I believe that the ground should be looked upon as one centre, the pelvis another; the superincumbent weight of the body being an applied power, which induces lateral movement in the two levers—hence the deformity. The distance between the feet is referable to the fact, that they must accommodate themselves to the obliquity of the femur and tibia, which results from the whole angle's being thrown outwards from the pelvic centre. I was principally led to hold the opinions which I now advance, from having often observed, that upon the application of an apparatus to these cases, the rectilineal form of the instrument became an unchangeable base, the leg and thigh mutually conforming themselves to its plane of direction; thus clearly proving, that the heel of the boot and the hip-joint are the two points whence the femur and tibia rotate inwardly as will be seen by the following diagram:—

If my reasoning be valid, the necessity of treating "genu-valgum" by almost entirely suspending flexion of the knee-joint is at once decided in the affirmative; for when the leg bends in an anterior direction, a large amount of lateral traction is at once lost, through the disposition manifested by the apparatus to inward rotation at the pelvis, and the consequent destruction of the plane of inversion.

FIG. 50.



a. Is the upper or femoral lever.

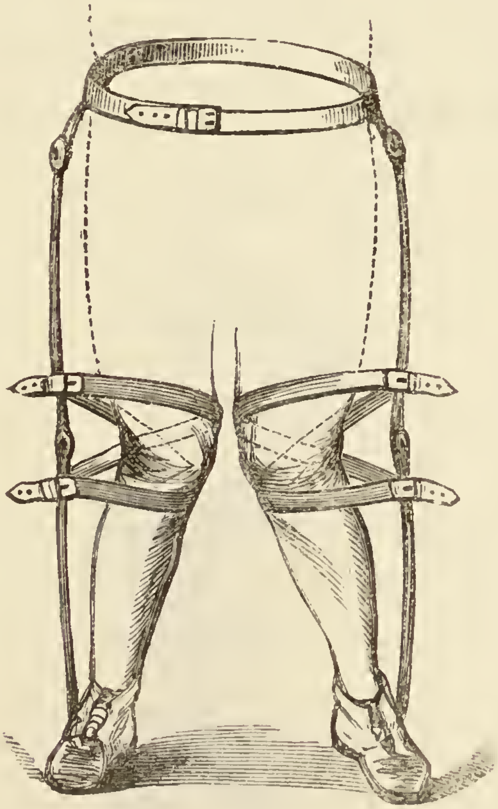
b. The lower, or tibio-tarsal.

When power is applied at *c*, the levers *a* and *b* move in an outward direction; their several centres *d* and *e* moving upwards and downwards respectively.

In cases of simple ligamentous weakness, instruments furnished with knee-joints are very useful, as they aid in sustaining the perpendicular position of the limb; but where there is deflexion to any serious extent, nothing will be able to overcome the deformity, in a steady and scientific manner, but an apparatus without joints, save at the hip and ankle, extending from the pelvis to the ground.

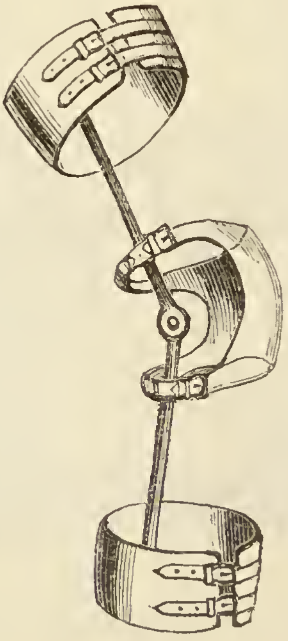
I will now proceed to the description of various instruments which are used in the treatment of this malady; commencing with such as are constructed with articulated levers.

Fig. 51.



In the first, two lateral stems, with ankle, knee, and hip-joints, extend from the heel to the pelvis, each being secured at its upper extremity to a padded pelvic band, which encircles the body; at the lower, to a tubular socket in the heel of the boot, and to the leg, by two padded straps, one of which arises from the thigh-stem, and is fastened in front to the lowermost, after having crossed from behind over the inner condyle; the second, which likewise passes round the back of the knee over the condyle, being secured to the upper strap. Thus they act alternately; the upper strap contributing to support the head of the tibia, and the lower one that of the femur—their combined direction of force being *outwards.*

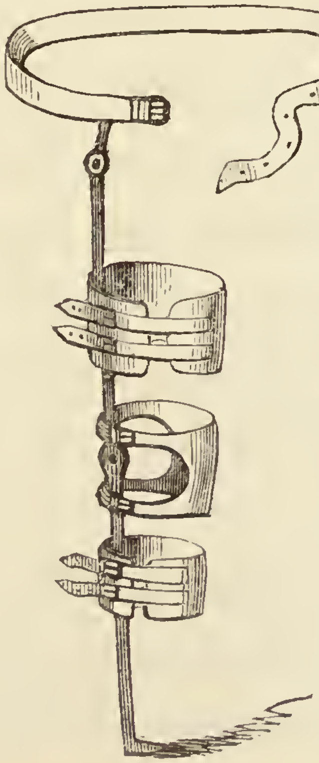
FIG. 52.



This instrument is exceedingly light, and, as it admits of free muscular motion, answers admirably in ordinary cases.

The second kind of instrument is also furnished with a knee-joint; but, instead of being attached to the pelvis, it terminates *above*, at about the middle of the thigh, and below, at mid-calf, by two padded bands. The knee itself is supported by a strong knee-cap, which is fastened to the thigh and leg levers, the principal advantage of the apparatus being, that it can be entirely concealed by the dress; hence, when a lady is under treatment for "knock-knees," this instrument can be worn without attracting notice.

FIG. 53.



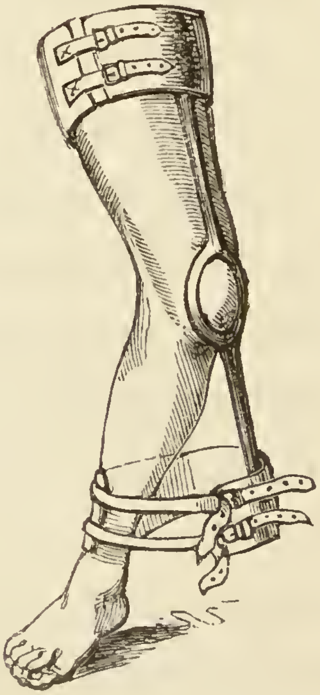
The third form of articulated apparatus is nothing more than a slight modification of the one first described; but, instead of using two straps as tractors, a knee-cap is substituted. Another palpable point of difference is, that the leg and thigh are mutually influenced by padded metal bands, which surround each of them, and greatly diminish the loss of mechanical power attendant upon genuflexion, when an instrument is secured to the leg by straps alone. It is doubtless the best of all the articulated leg instruments which are used in the treatment of "knock-knees."

It is likewise furnished with a joint coincident with the axis of the ankle, and the boots are firmly rivetted to the instruments, instead of being placed in a tubular socket, so that when the apparatus is applied, it attaches itself closely to the body. It will readily be seen, that when the shafts of the leg and thigh are grasped by the upper and lower bands, a great control must be gained over the lateral deflexion, which is always present in this deformity.

I have next to describe an instrument of a very remarkable character, since it is constructed upon a principle which is open to considerable discussion. It was invented by Mr. Hester, of Oxford, by whose instructions I applied it, with very promising results, to a lady patient of his, about four years ago. I have had no other opportunity of trying this kind of appliance, and on this account refrain from hazarding an opinion as to the probabilities of its efficacy in ordinary cases. Its peculiarities are based upon a theory, "that the lower part of the leg (tibia and tarsus) rotates from the inferior extremity of the femur, in an outward direction, and that the thigh always holds its original and perfect position." I have already stated, that I am convinced that the femur and tibia become mutually oblique in the formation of genu-valgum; still, I am bound to admit that, supposing the action which I am about to describe to be successful, the obliquity of the thigh may be overcome by the application of an instrument to the *inner side* of the leg, consequently inducing an increase in the space between the internal condyles, with reduction of the femoral obliquity. The instrument is constructed of two levers, with a large hollow-jointed disc at their point of junction, which receives the internal condyle within its circumference. Of these levers, one corresponds with the *proper* line of the thigh, the other, with that of the leg, and both terminate by padded metal bands; the upper one surrounding the thigh, the lower the calf. When the upper stem is fixed firmly to the thigh, a space is left between the inferior extremity of the lower stem, and the internal malleolus of the tibia, proportional, of course, to the angularity of the limb; which space must be reduced by fastening the lower padded band as tightly as the patient can bear it.

In the mechanical action of this instrument, the thigh lever becomes a fixed point, its major fulcrum being situated at the inner condyle;

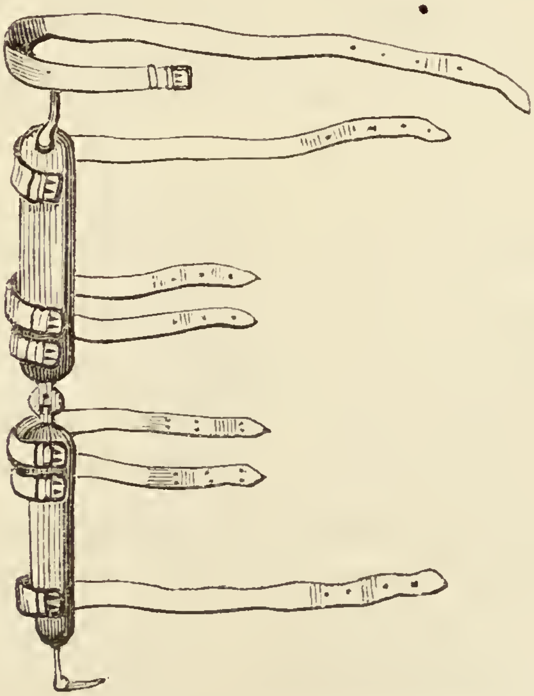
FIG. 54.



while, as the resistance to be overcome is afforded by the lower leg, the calf-band presents the required means for reducing the space between the tibia and leg-stem. Genuflexion can be performed at pleasure during the whole period of treatment, the knee-disc forming a ring-joint.

In the next class of instruments, the knee-joint is held in a fixed position. The simplest of these consists of a long padded splint, extending from the greater trochanter to the heel of the boot, where it fits into a tubular socket. The upper part of this splint is fixed

FIG. 55.



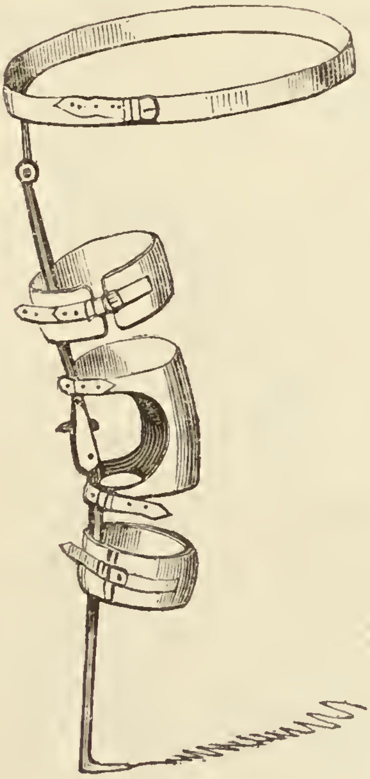
to the body by means of a hip-joint in a padded pelvic band, and the angle formed by the leg and thigh is gradually reduced by the pressure of a strong and broad webbing strap, which surrounds the knee. In the Orthopædic Hospital, these splints are rarely attached to the boot; consequently they lose much of their efficacy by rotating upon the limb.*

In the next appliance, based upon this principle, a padded pelvic band attaches a perpendicular lever on each side, which passes down the outer side of the leg, and is furnished with free centres at the hip and ankle-joints; that at the knee, however, being fitted with a tangential screw, the axis of which, through being rectangular to the leg, consequently, only admits of extension in the plane of the leg's inversion. The thigh and calf are surrounded by padded metal bands, which are fixed to the lateral stem. When this instrument is applied, the ratchet-joint should be made to correspond, in its direction and degree of angularity, with the inverted knee; and as the knee itself is firmly grasped by a broad webbing, whilst the calf and thigh are held by the metal bands, the extension of the knee-screw *outwards* produces a pressure upon the pelvis and heel,

---

* I am indebted to Mr. Cæsar Hawkins for an admirable modification of this instrument. It consists in placing a stop-joint at the knee, so arranged as to admit of the splints being flexed to such an extent as will enable the patient, when walking, to throw the legs forward without engendering rotative movement at the hip-joints. Of course this is accomplished by not permitting the flexor action to extend further than will just suffice to clear the foot off the ground, without weakening the lateral mechanical traction of the apparatus. I have also added a screw, turned by a key in such a manner, that it increases or decreases the angle of flexion, at pleasure.

Fig. 56.

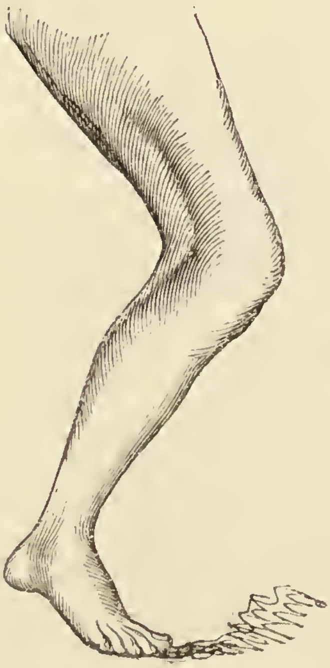


together with a diminution of the angularity of the knee by depression of its apex; and the leg will gradually regain a straight form, by being drawn parallel with the external levers, or leg-stems.

Every principle essential for the treatment of knock-knee will be found embodied in the foregoing apparatuses; it is desirable, however, that some idea should be given as to which is the best in particular instances of this distortion. It has been found from long experience that the instrument described at page 153 is the most efficacious in simple cases; that at page 159 in secondary cases; that at page 161 for the severest.

When lateral inversion has proceeded to that point, where the line of gravity no longer coincides with the perpendicular, or normal, centre of the limb, contraction frequently results in a posterior direction, this being the compensation afforded by Nature towards the sustenance of the bodily weight within the area of the foot. In this case, the deformity must be treated on a plan differing from any of those which have hitherto been suggested—viz., the angular contraction of the knee in its mesial plane must be overcome in the first place, and then the lateral inversion. The mechanism for accomplishing this is but a modification of the last apparatus, the only difference being, that instead of one, there are two ratchet-joints at the knee, the axes of which are rectangular to each other; thus the one ratchet-wheel extends the leg from the thigh, while the other overcomes the inversion. Whilst noticing this instrument, I am insensibly led to consider the next variety of the deformities which affect the legs—viz., "contraction of the knee, unaccompanied by lateral

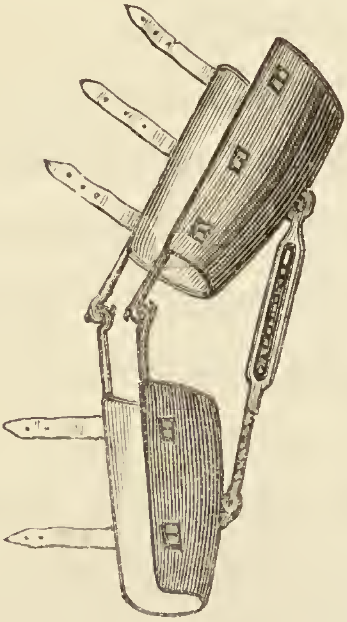
Fig. 57.



inversion." The instruments used for the purpose of overcoming this distortion are so numerous, that an attempt to describe one-tenth of them would be futile. I merely intend to give those which are most applicable for the treatment of this deformity.

Contraction of the knee is due to a lessening in length of the muscles of the back of the knee, or "popliteal space." Of course I do not mean to say anything so absurd as that knee-contraction originates in this way only, for very frequently the muscles just alluded to have simply adapted themselves to the flexed condition which is assumed by the knee-joint, in certain stages of diseased action. It may be simply positional, too, or arise in some other way. Whatever the proximate cause may be, the mechanical treatment is invariably immensely assisted by a division of the tendons of the semi-membranosus, semi-tendinosus, popliteus, and biceps flexor cruris muscles, as one of the greatest obstacles to extension is thereby removed. Nevertheless, there is one point relative to tenotomy which, I believe, has escaped observation up to the present time, *simply because its solution happens to be purely* *mechanical.* It is this, that there is a slight posterior luxation of the head of the tibia in almost all cases where this remedy has been resorted to. The explanation of this occurrence may be simplified by a description of the apparatus in ordinary use for straightening the knee-joint. When the flexion of the knee is trifling, the instrument usually employed for mechanically extending it, is a padded wooden or metal splint, hinged at the knee, and extended by means of a male and female screw; lastly, there is a knee-cap.

Fig. 58.



Any one examining this drawing, will find that upon extending the apparatus, the greatest amount of resistance must be found; first, at the anterior surface of the knee, over which the knee-cap passes; secondly, against the calf; and thirdly, at the thigh. The centre joint becomes the fixed point of rotation for the thigh and leg levers, thus diminishing the angle of the knee; but as the *tibia* is acted upon by the lower band and knee-cap in such a manner that it obtains a disposition to rotate backwards around its own centre; and as the same thing cannot occur at the thigh, because it is firmly fixed to the pelvis, posterior luxation of the head of the tibia must take place, although this is generally of so small an extent as to be hardly noticeable.

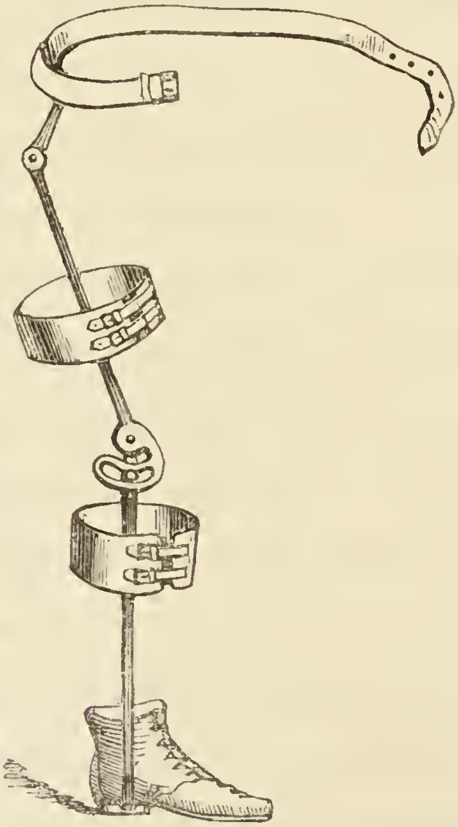
If the opinion which I have advanced be apparent from the illustration afforded by the action of this instrument where no *tenotomy* has been performed, how great must be the increase given to posterior rotation of the tibia, when the muscles connecting the leg with the thigh are severed:—for then the whole power exercised by the extending apparatus must necessarily be so directed as to assist in thrusting the head of the tibia backwards.

Notwithstanding this apparent objection, tenotomy offers immense advantages; but only where the instrument is so constructed that it will effect the intended result without producing the mal-action just described. Upon this ground, again, it must be admitted, that unless a mechanist be sufficiently scientific to perfectly comprehend the new directions taken by bones under certain abnormal circumstances, he will be incapable of affording the surgeon that assistance which the latter is justified in expecting at his hands. When the apparatus is properly made, it should embrace the head of the tibia posteriorly, and ought gradually to advance that point as the knee becomes extended by the remaining portions of the appliance. If required for a slight contraction, this is best effected by passing a strong webbing band at the back of the knee, just below the condyles, and rendering it tighter as the instrument is advanced towards a straight line.

The best known instruments for contraction of the knee, together with sundry of recent invention, are figured in the following pages.

The first consists of an instrument with a hip-joint, which is attached to the pelvis by a padded band. At the knee-joint there is a semi-circular disc, through an aperture in which a screw passes to a hole in the leg-stem, into which it is received. The lower part of the instrument is attached to a boot, the calf and thigh being embraced by padded bands. A webbing band, attached to the thigh and leg-stems, surrounds the knee, passing in front of it. Upon bringing the instrument into action,

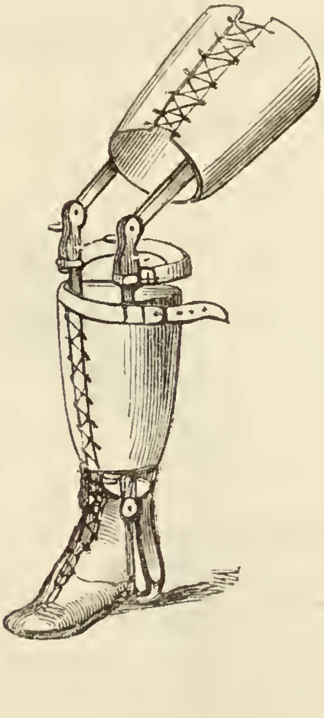
Fig. 59.



the leg is first of all extended by the force of the hand, and the segmental screw is then tightened, thereby diminishing the angle formed by the leg and thigh. It is needless to add that this is only intended for use in very slight cases.

The next kind of instrument is composed of two metal troughs, one for the reception of the thigh, the other of the leg. These troughs are joined by two lateral stems, having ratchet-joints situated at their centres. A webbing-band passes at the back of the apparatus, just below the centre of the knee-joint, which prevents posterior luxation during the extension of the contracted limb. When

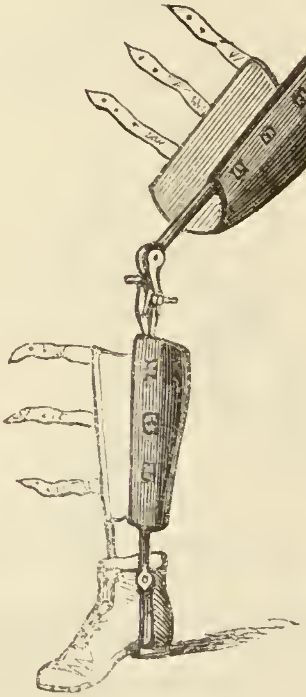
Fig. 60.



this instrument is set in action by turning the tangential screws at the knee, the ensuing extension of the two levers which form the thigh and leg-stems, induces pressure upon the patella, together with a change in the angularity of the limb. This instrument is peculiarly well calculated to overcome the distortion in all ordinary cases of contracted knee, and it is likewise so simple as regards its mode of application, that the occurrence of an error in mechanical manipulation is rendered almost an impossibility.

Where, as sometimes happens, contraction of the knee in its mesial plane is accompanied

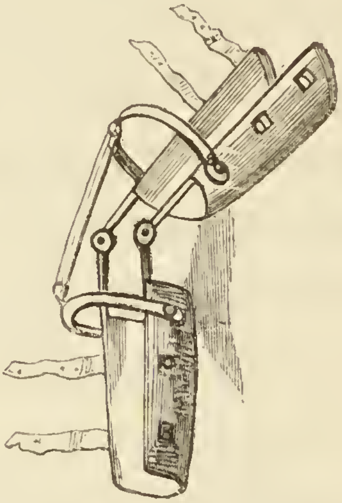
FIG. 61.



by lateral inversion, the following instrument will be found available. One padded trough receives the thigh, another the calf, these two being connected, on the outer side, by a single lateral stem, furnished with two rack-and-pinion joints, each acting at right angles with the other. A strong knee-cap is then fixed to the extremities of the leg and thigh troughs. When acting mechanically upon the limb with this instrument, the one axis entails extension, and the other lateral eversion;—thus the knee is gradually restored to its proper position.

I have recently devised a very ingenious plan for the extension of the knee in ordinary cases, by directing the tractile force of powerful india-rubber straps upon the instrument, in such a way as to induce straightening of the knee, and, at the same time, admit of some slight amount of motion in the joint. This plan is practically carried out, by adjusting two troughs to the limb,—one for the thigh, the other for the calf,—and joining them together by two lateral levers, each *freely-jointed* at the knee. Two semicircles of metal are fixed to these levers, midway between the two troughs, for the purpose of affording attachment to strong bands of vulcanized india-rubber. The constant traction of this elastic substance maintains a never-ceasing *extensile* force upon the contracted muscles, and, if the action of the apparatus is assisted by tenotomy, the limb soon becomes restored to a normal position.*

FIG. 62.



In the apparatuses which I have described as being applicable for the restoration of a contracted knee to the straight position, it has frequently been found that, owing to the amount of yielding given by the muscular surface which forms the back of the leg and thigh, the lateral stems have become perfectly vertical, the limb, notwithstanding, retaining a slight amount of angular retraction. In order that I might obviate this, I recently devised an apparatus for the cure of "contracted knee," by the action of which power is so applied, from the very moment at which extension commences, that the knee is drawn backwards, whilst the leg and thigh are simultaneously thrust forward. Although all the former instruments induce extension of the leg and thigh, none of them resemble this one, in aiming at an active depression of the angle of genuflexion at its apex. The others simply offer a passive resistance over the anterior surface of the knee, while the leg and thigh are being extended. I shall probably render my meaning more intelligible by explaining how this instrument is constructed.

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* A strong knee-cap is attached to all these knee instruments with a view of preventing the knee from being uplifted from the apparatus when mechanical power is applied, and as a necessary counter-resistance to the extension produced by the lateral levers.

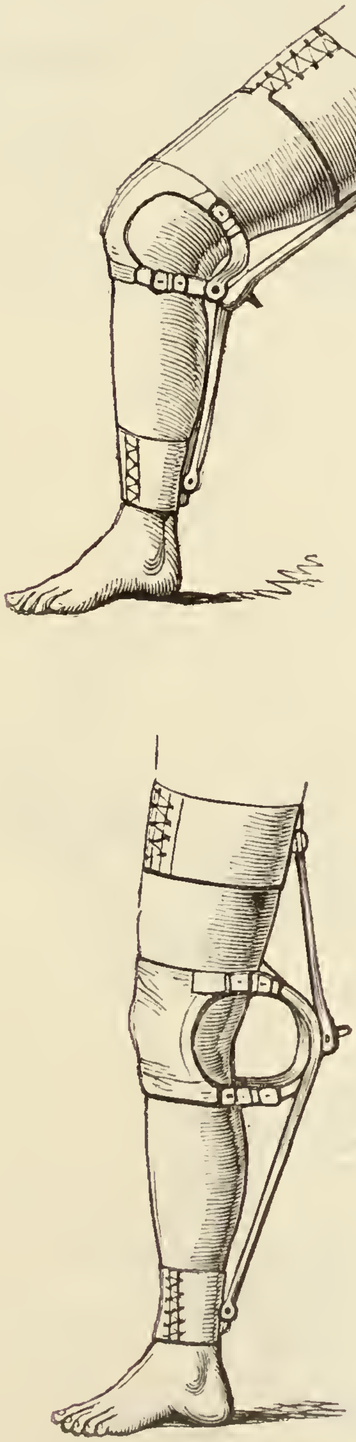
It is composed of two steel levers, joined together by a ratchet-joint at the back of the knee, by means of which they can be so moved as to coincide with any "angle of contraction."

A padded band, passing over the back of the thigh, is attached by a hinge to the upper extremity of the levers: this allows of a ginglymoid motion in the levers, when they are acted upon by the ratchet-screws. Another band is attached to their lower extremities by a similar hinge. Four small steel arms spring from the ratchet-hinge in such a manner that they pass on either side of the knee, giving attachment to a strong leathern cap, which crosses over the front of the joint.

When this is adjusted, and the ratchet-screw is moved in a posterior direction, the two levers are extended anteriorly; but, as their extremities are hinged to the bands which surround the calf and thigh, the entire posterior stem acquires a tendency to backward motion, drawing the knee, of course, in the same direction. This action may be continued, until the ratchet-centre reaches a point *behind the vertical line*, or, in other words, "reverses its angle;" the entire restoration of the great bones of the limb to a vertical position being hereby fully ensured.

It is difficult to describe this instrument satisfactorily, although the results obtained by its use are indisputably favourable. It fairly removes that contractile tendency which always

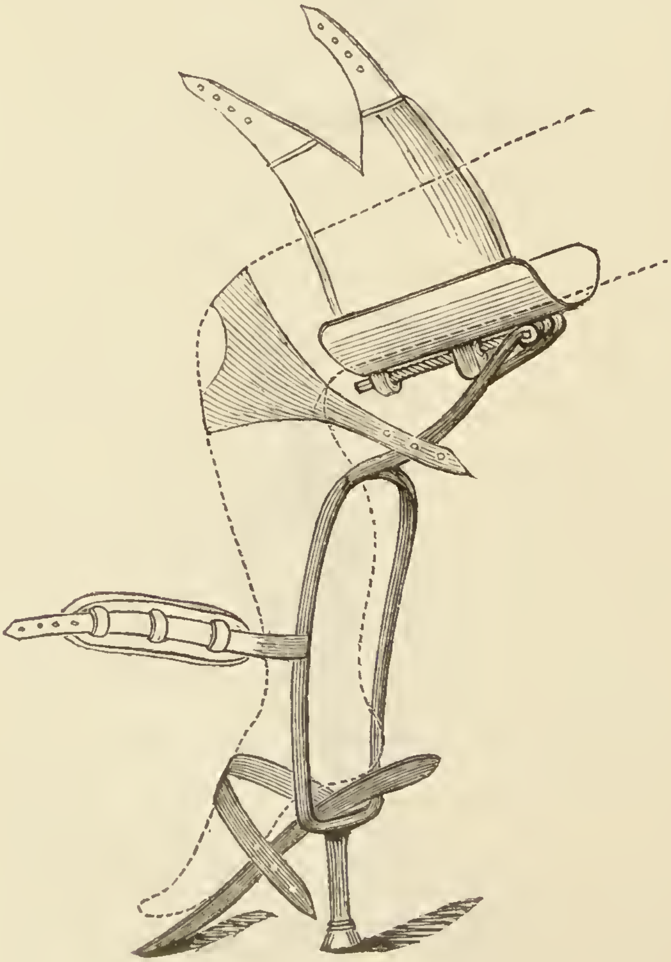
Fig. 63.



remains, where the angularity has not been completely conquered, at the same time that it prepares the knee for the reception of frictional exercise, which must be employed, in all cases, ere motion can be restored to the joint after it has been mechanically extended.

Although not strictly an instrument for "contracted knee," the following apparatus will be found very useful, where there is a

Fig. 64.



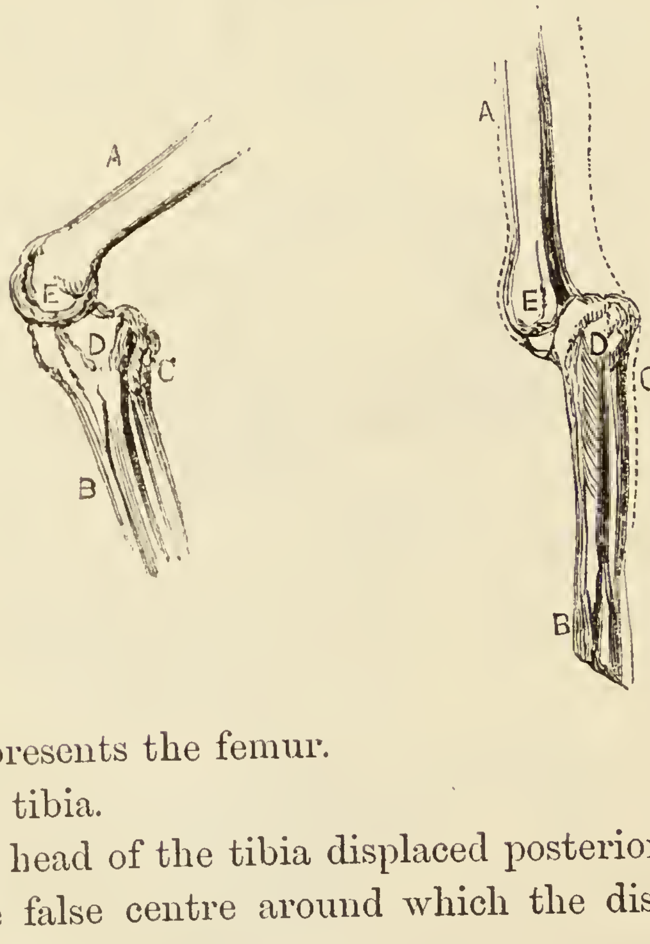
permanent shortening in the length of the leg, in its relations with the ground, from Anchylosis:—

It consists of a padded thigh trough, attached to a powerful metal stem by a hinge; the stem bifurcating just above the calf, and joining a foot-plate below. A small tube, or socket, is sunk in the lower surface of the foot-plate, for the reception of a wooden pin, which fills up the space existing between the foot and the ground. A strong knee-cap passes over the patella and secures the leg firmly to the apparatus.

When the patient uses an instrument of this kind, his weight is received by the thigh trough, and transmitted thence to the ground, so that the knee is guarded from all strains, while the tendency to vertebral curvature, which is always induced by a contracted state of the lower limb, is at once arrested and negatived.

Another condition assumed by the knee, for which very complex mechanisms have usually been constructed, is known as "posterior displacement of the tibia, beneath the extremity of the femur." Where this is present, any attempt at reducing the angle of the knee by an instrument which possesses but one knee-axis, must not only be ineffectual, but it will positively tend to increase the displacement of the tibia. The reason of this needs explanation. Upon carefully examining a knee so contracted that the head of the tibia exhibits itself posteriorly beneath the extremity

FIG. 65.



A. Represents the femur.

B. The tibia.

C. The head of the tibia displaced posteriorly.

D. The false centre around which the displaced bone rotates posteriorly.

E. Natural axis of the knee-joint.

of the femur, it will instantly be apparent that another centre of motion must be established, in lieu of that upon which the leg flexes in its normal state; and, consequently, that this false centre must first be so advanced as to be re-established at the point where the true centre originally existed, before the limb can be restored to its vertical position. This can only be understood correctly through a diagram.

Upon attempting to extend the knee by any ordinary appliance, the mechanical result must be to make the tibia rotate upon the false axis D, which would leave the head of the bone in a position of backward dislocation, even if this movement succeeded in overcoming the abnormal flexion or contraction. In order to avoid this, the head of the tibia must be advanced anteriorly beneath the extremity of the femur, concurrent with the attempt being made to extend the limb. The instrument best fitted to effect this is made as follows:*—

---

* An admirable description of this instrument has appeared in the *Lancet*, penned by Mr. Erichsen, who originally suggested its construction.

A metal stem, containing two free joints, so arranged as to correspond by their centres with the axes of the extremity of the femur and head of the tibia respectively, passes down on either side of the limb, to which it is attached by padded metal thigh and calf troughs. When applied, this instrument conforms itself with tolerable accuracy to the shape of the malformed limb. A perpendicular spring is fixed to that portion of the apparatus which is situated in a line with the thigh, above the first of the free centres, the action of which said spring presses the end of the femur backwards; while below the second centre, and in a line with the tibia, another spring is attached, the mechanical power of which urges the head of the tibia forwards; thus we obtain two antagonistic forces, both tending to bring the head of the tibia beneath the extremity of the femur, and, at the same time, extend the angle of contraction. If the deformity is one of very great severity, it is better to use ratchet screw centres than to act by the power of strong springs.* This instrument requires to be mechanically managed in a most peculiar fashion, when in action, since the success of a case will depend upon the ratchet's being screwed in a proper order. It is thus used: After applying the instrument, so adjusted by means of the screw centres that the axes of its joints shall coincide with those of the femur and tibia, the first movement which must be given is that of flexion of the lower centre, by which the head of the tibia is thrown forwards, but, at the same time this increases the angle of contraction. If the upper rack be now extended, the entire tibia is made to rotate in an anterior direction beneath the head of the femur, and the angle of deformity is considerably diminished. By following in this sequence, when acting upon the distortion, the limb can be gradually restored to a normal condition, without fear of any of the posterior luxation's remaining unreduced. It will be apparent that, in the second of the actions just described, the upper axis becomes a fixed point, around which the radius of motion, which takes place between it and the lower centre, rotates; and, as the lower centre is connected with the leg trough, the tibia must, of necessity, advance with the instrument, and in this way complete the extension and replacement of its head. The spring instrument acts in like manner, but, owing to its being self-adapting, its action cannot be so readily demonstrated.

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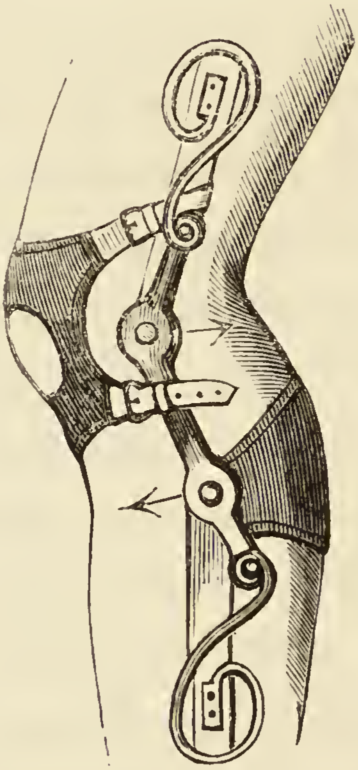
* I constructed the first instrument made on this rack-and-pinion plan for a patient under the care of Mr. Brodhurst.

FIG. 66.



An apparatus sometimes recommended for the treatment of a malformity of this description* consists of a mahogany board with perpendicular lateral stems, to which a webbing band, passing like a sling under the head of the tibia, is attached. The thigh is firmly bound to fixed pads belonging to the board, and the ankle is grasped by a bandage which is secured to a horizontal screw, the object of which latter appendage is, elongation of the leg. A pad, regulated by a screw, is placed over the anterior and inferior surface of the thigh, pressing the femur downwards, and giving counteraction against the webbing band which passes underneath the head of the tibia; there is also an arrangement for the prevention of lateral displacement of the head of this bone. This instrument, although very ingenious, considering the period at which it was devised, is far too clumsy to be generally adopted in the present advanced state of science, as it not

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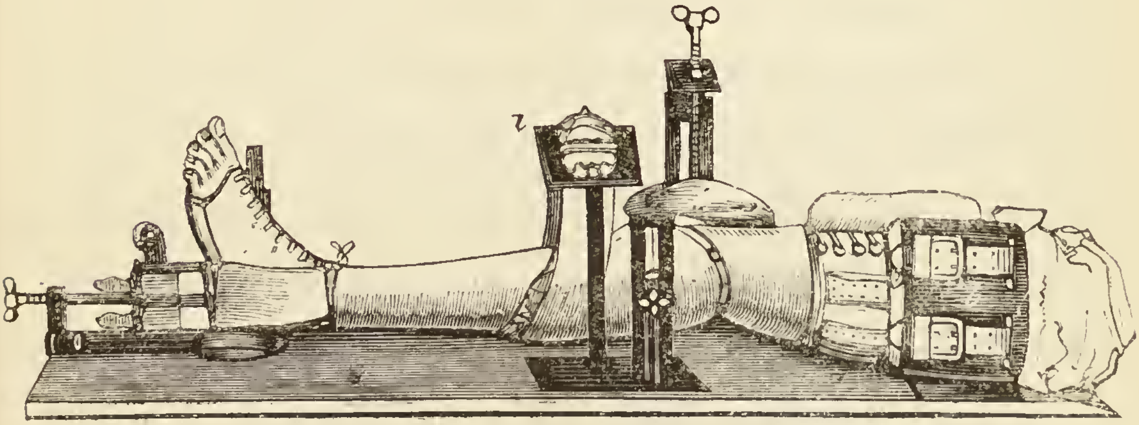
* *Vide* Little *On Deformities*, page 80.

FIG. 67.



only restricts the patient to his couch, but is entirely useless where the knee presents much posterior flexion.

"Posterior luxation of the tibia *without* angular contraction between the leg and thigh," is another of those malformities which are incidental to the knee. A very ingenious instrument (which I constructed for a patient of Dr. Little's at his suggestion) is thus made: Two lateral levers, hinged at the knee, are attached to the limb by thigh and leg-troughs, so proportioned that the upper trough embraces the thigh from the ischium to the commencement of the condyles, while the lower one surrounds the leg from just above the malleoli to the tibial tuberosities. At the back of each trough, and to its centre, a small hook is fixed, and on these hooks a ring of vulcanized india-rubber is stretched, the action of which flexes the apparatus, and thus overcomes the disposition entertained by the knee to backward flexion. From the elastic nature of the applied power, it is impossible that any permanent contraction of the knee-joint can result.

I need scarcely remark that a strong knee-cap is a necessary and constant appendage to all contrivances intended to act upon the knee-joint; since, if this precaution were neglected, the apex of the angle formed by the leg and thigh would remain undiminished, and the efficiency of the mechanical appliance would be necessarily abrogated.

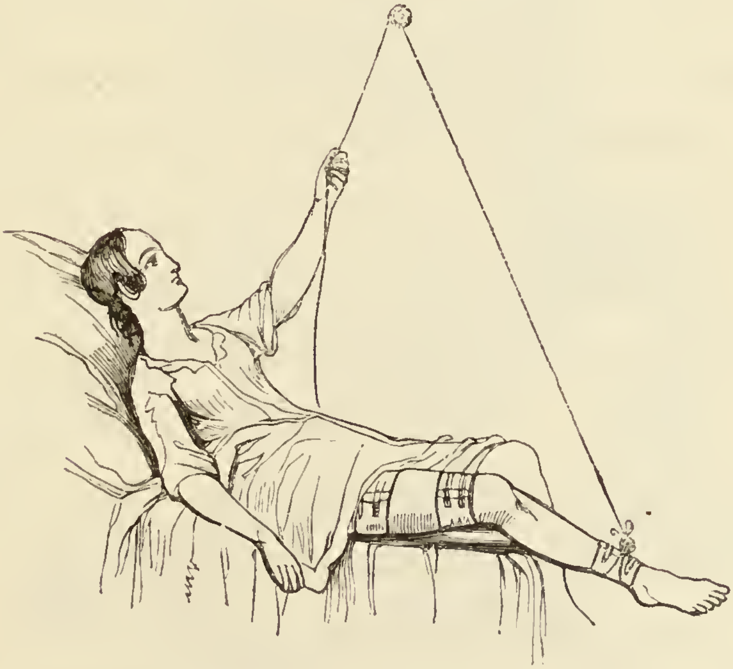
CHAPTER VI.

CONTRACTED KNEE CONTINUED.

In the last chapter, I endeavoured to show that angular contraction of the knee, whether accompanied by luxation or the contrary, can be readily overcome by the adoption of proper mechanical means. I shall now proceed to the description of such instruments as are employed for the purpose of re-establishing muscular motion, after the joint has been brought into a normal position, since it is necessary to show not only by what apparatus the limb can be best straightened, but also the one by which it may be most readily retained in its restored position, and by which mobility and natural action may be imparted to the joint.

The simplest of these consists of a wooden chair, upon which the patient sits, the thigh being surrounded and held tightly to its surface by two broad straps. A padded band, furnished with buckles and straps, is attached to the ankle; a cord which passes over a pulley fixed in the ceiling connecting the hand of the patient with the end of the lower leg. Upon pulling this cord, the knee is extended, but it is necessary that the muscles which form the back of the leg (flexors) be put in action, before the limb can be again reduced to an angular position—in this way an easily regulated motion of the knee-joint is obtained.

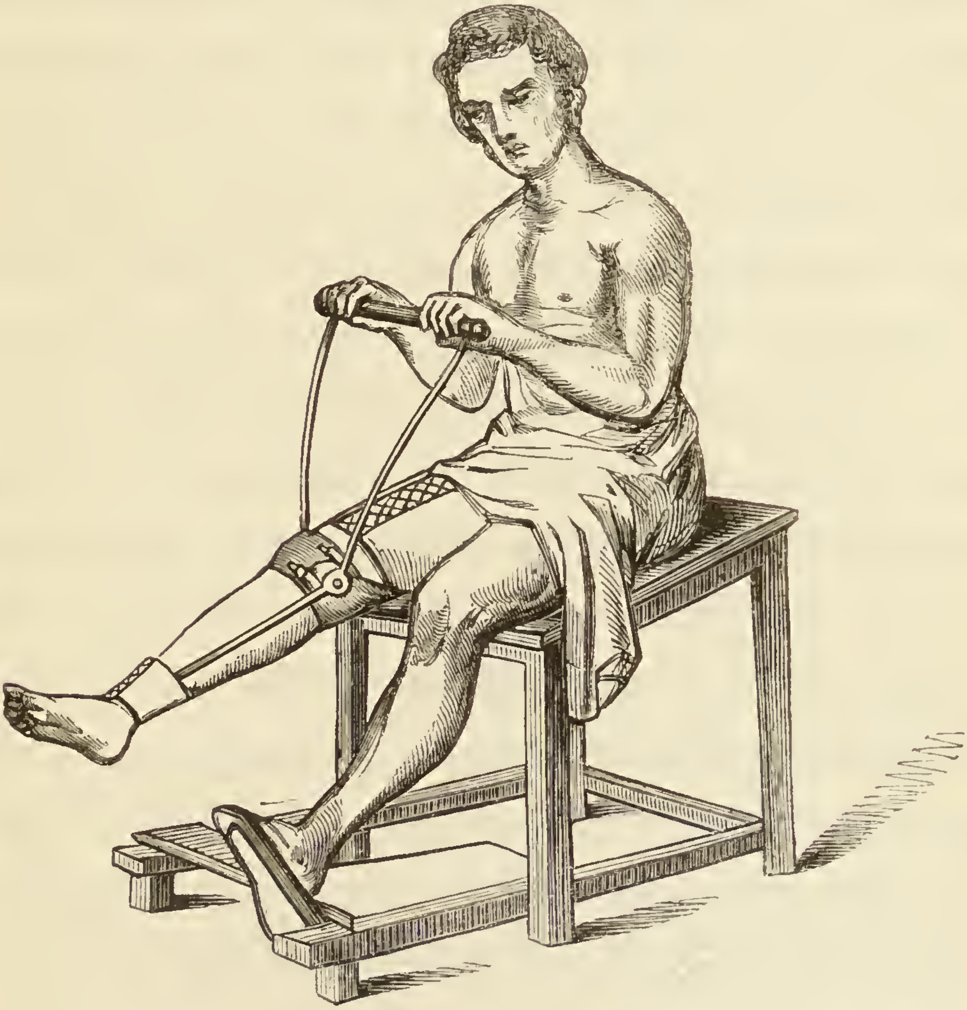
Fig. 68.



The next appliance is of a still more complex character, its intention being to re-establish regular and well-sustained flexion and extension, independently of any muscular aid which might be received from the flexors of the patient, as in the last apparatus, where they are allowed to draw the cord, previously employed in extending the limb, *downwards*. This apparatus consists of a strong wooden seat, fixed in a square frame which rests upon the ground. A padded thigh-trough, with two pivots at its inferior extremity (opposite to the centre of the knee-joint), is firmly attached to that part of the seat on which the patient's body rests. To these pivots, and rotating around them, a double lateral lever is fixed, the upper extremity of which ends in a cross-bar, acted upon by the hands; whilst the lower end forms an ankle-trough, to which the patient's leg is firmly secured. Upon pressing the cross-bar forwards with the hands, the knee is flexed, while by drawing it towards the body the leg is again extended; thus producing the action which is of all others the one most essential for the restoration of mobility to the joint.

In order that the patient may have the power of exercising considerable force (if needed) against the hand-rail, and, thence, on the knee; the foot of the sound limb rests upon a small piece of board, which is secured to the front of the frame, and has also the effect of steadying the patient's body while the apparatus is in motion. The pelvis is likewise held firmly to the seat of the apparatus, by a well-padded strap passing directly across the lower part of the abdomen, and fastened securely to

Fig. 69.



the opposite side. The mechanical action of this apparatus may be thus explained:—As the thigh and pelvis are held firmly to the seat, a fixed point is afforded against which the lateral levers may act. These are so curved that the limb is flexed to a right angle when their upper arm is thrust forwards, and extended to a straight line when it is drawn back to the body; the reason of this being, that the lower arm, or portion anterior to the centre of motion, forms the radius of a circle described from the knee-joint as a centre, to the heel as a point in the periphery; therefore, as this lower arm is but a continuation of the upper one, the space traversed by the former is represented in the latter by a distance proportionate to the longitudinal difference between the levers; thus, if the radius of the lower lever be eighteen inches, that of the upper six—the lower will move through three inches of space to every one traversed by the upper: it therefore follows, that if the arms of the lever are carefully proportioned, as regards length, a great range of motion may be gained for the knee without imposing much labour on the patient.

Perfect mobility of the joint may readily be obtained with either of the instruments which I have described, for unless some such course be pursued, the knee will, in all probability, RECONTRACT. In order to prevent this, even when the limb is exercised, the patient usually wears (when not using the apparatus just described) an instrument passing from the pelvis to the ground, and furnished with hinge-joints at the hip, knee, and ankle. There is a small screw at the knee-joint of this instrument, by which its action can be arrested, since it is often desirable that the knee should be kept fixed during the greater portion of the day, and motion be permitted only when the patient can give his undivided attention to the process of locomotion.

Another of the malformities of the knee, for which mechanical appliances are used, is termed "Lateral displacement of the head of the tibia in an outward direction." The apparatus by which this can be overcome consists of a lateral metal stem, attached to the leg by thigh and calf-troughs, and fitted with two rack-and-pinion centres; one of which corresponds with the axis of the knee-joint, the other moving rectangularly above it. The inferior extremity of the leg-stem is fixed to a laced boot, which gives the instrument a perfect control over the limb, both in lateral and anterior extension. In form this instrument resembles that depicted at page 170, with the addition of a rack, intended to restore the tibia to the vertical plane.

"Vertical rotation of the tibia," is occasionally complicated with cases of "knee-contraction. This *mal de genou* can be removed mechanically, by placing a *horizontal* rack-and-pinion joint *immediately below* the extending centre of an instrument similar to that shown at page 170. The reason why it must be below the ratchet which governs the extension of the limb, is, that the femoral part of the appliance then becomes a fixed point for tibial rotation; this arrangement being in accordance with the anatomical conditions observed, when the position of the tibia has been changed as regards its longitudinal axis. It is not necessary to give an engraving of this instrument, for it is a mere modification of that just mentioned. As regards the two instruments last described —the one for lateral displacement, the other for vertical rotation of the tibia—it is highly important that we should mark the relative positions held by that ratchet centre which is especially intended for the correction of either deformity. In the former case, the ratchet is placed *above*, in the latter, *below* the extending joint; for if these conditions were neglected, or reversed, the instrument would be rendered entirely useless; a circumstance which affords another illustration of the great necessity there is, that the mechanist should correctly understand the osseous mal-position of the part upon which his apparatus is intended to act. I have seen several instruments in which the rule just enunciated has been ignored, the non-success following their application fully illustrating the necessity of paying great attention to these ratchets.

"Curvature of the femur *anteriorly*" is sometimes met with in combination with contraction of the knee; but, unhappily, the mechanical treatment employed for this deformity has been so very unsuccessful in producing beneficial results, as to render the mechanisms employed scarce worthy of notice. The instrument usually adopted consists of a lateral stem, attached below to the foot, and above to a pelvic band. Hinged joints, opposite to the knee, ankle, and hip, correspond with the actions of these several articulations. That at the hip is furnished with a stop, which, whilst allowing the joint to be bent freely in an anterior direction, opposes any tendency which may exist for posterior flexion. A padded metal plate passes over the front of the femur, at the centre of the lateral stem which extends between the hip and knee; while a strong steel plate, covering the gluteal region at the back of the pelvic band, produces some little resistance, by its lower edge, against the posterior surface of the upper third of the femur. A small padded metal band likewise passes over the back of the lower third of the thigh, just above the condyles. The mechanical action induced by this contrivance theoretically, tends to diminish the arc of femoral curvature, by exercising pressure against its anterior surface, and extending its extremities. The use of it, however, is rarely attended with benefit, as the *necessary* motion of the hip-joint greatly diminishes, even if it does not entirely nullify, the pressure of the gluteal plate.

I have now to attempt a description of those instruments which are most usually adopted for the treatment of "Contracted Hip-joint," and although they are *numerically few*, yet *in importance* they undoubtedly surpass all that I have hitherto treated on.

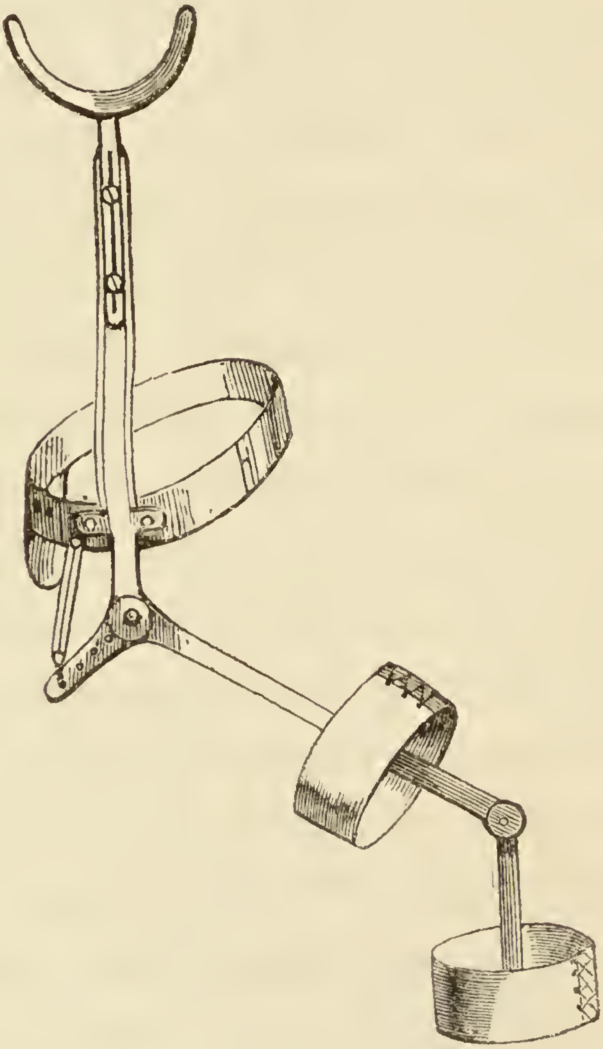
All are more or less familiar with the external characteristics of this malady in ordinary cases—viz., a flexion of the thigh upon the trunk, with consequent shortening of the limb, so that it cannot touch the ground, a symptom which invariably necessitates the employment of crutches as aids in locomotion; but few save those who are professionally compelled to examine these cases carefully, are aware of the vast amount of mechanical disturbance to which the bones of the hip and thigh are subjected, by the protracted duration of a contraction at this joint. There are several sound mechanical reasons why the hip-joint should offer difficulties of no ordinary character to the constructor of the scientific appliances which are made use of, for the purpose of counteracting the malformity ultimately engendered during the progress of these cases, the most prominent, perhaps, being the peculiarity of the angle at which the shaft of the femur is set, in its relations with the pelvis. In almost all the other articulations of the limb, the shaft of the bone is in a right line with the centre of its articulation with a neighbouring bone; but in the femur, the articulating medium through which it is directly attached to the pelvis, is nearly at right angles to its shaft, or main longitudinal axis; the result of this is, that the weight of the body is principally sustained by a small arch, termed the neck of the femur. This angularity gives great advantage *mechanically*, when the limb is sound, by assisting in breaking any sudden shock which might be inflicted on the lower limbs, as, *par exemple*, in the act of jumping from a height, &c.; but when the thigh becomes permanently flexed upon the trunk, this condition is altered, for the angular neck of the femur *then* exercises a prejudicial leverage against the ligaments, &c., by which the head is secured in the acetabulum (or socket in the pelvis). If, in addition to the mere mechanical mal-influence exerted upon the capsular ligament, debility of structure, from disease, be also present, an explanation is given of the cause which so frequently engenders a threefold deviation of the hip-joint from its natural condition—viz., permanent flexion, adduction, and inward rotation of the limb.

Sometimes there is a fourth deviation, the existence of which will offer even greater obstacles to the successful employment of mechanical force than either of the three just mentioned—viz., luxation of the head of the femur on to the ala of the ilium, necessitating, for its reduction, the employment of an elongating force; the exercise of this said force being greatly retarded, and opposed, by the flexed position of the limb. Under every circumstance, contraction of the hip-joint cannot be successfully treated by mechanical appliances, unless they are constructed with the view of being firmly attached to the pelvis and thorax; for as the lever formed by the leg and thigh is very much longer than that existing between the thigh and pelvis, any attempt at extension of the former, without giving it a fixed point on the trunk, is manifestly unscientific.

I invented the following apparatus for a patient of Mr. Weedon Cooke's, at the Royal Free

Hospital, and as it possesses the advantage of allowing free muscular motion while the limb is being extended, it is productive of much benefit in slight cases.

FIG. 70.

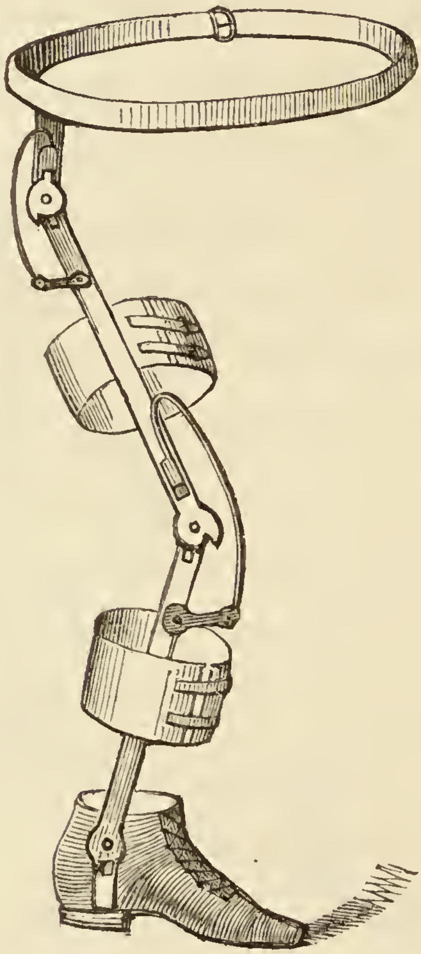


This instrument is composed of a lateral metal stem, extending from the arm-pit to the centre of the calf, possessing free joints at the knee and hip, and attached to the body by a padded pelvic band. At the centre of the stem, between the hip and knee joints, a padded metal band passes over the front of the thigh, while at its lower extremity there is a metallic trough, which receives the back of the calf. The perpendicular upright upon which the axilla rests, is prolonged to a point situated just beneath the hip-joints, arching thence backwards. A strong vulcanized india-rubber ring is stretched from the extremity of this to the thigh-bone, the retraction of which exerts a constant expansive power on the flexors of the thigh. A gluteal plate is attached to the lower edge of the pelvic band, which is intended to prevent the head of the femur from being thrust backwards, and, also, to add to the power of the apparatus.

This instrument completely extended the thigh, and in a very brief period too; owing, probably, to the constancy of the traction exerted by it.

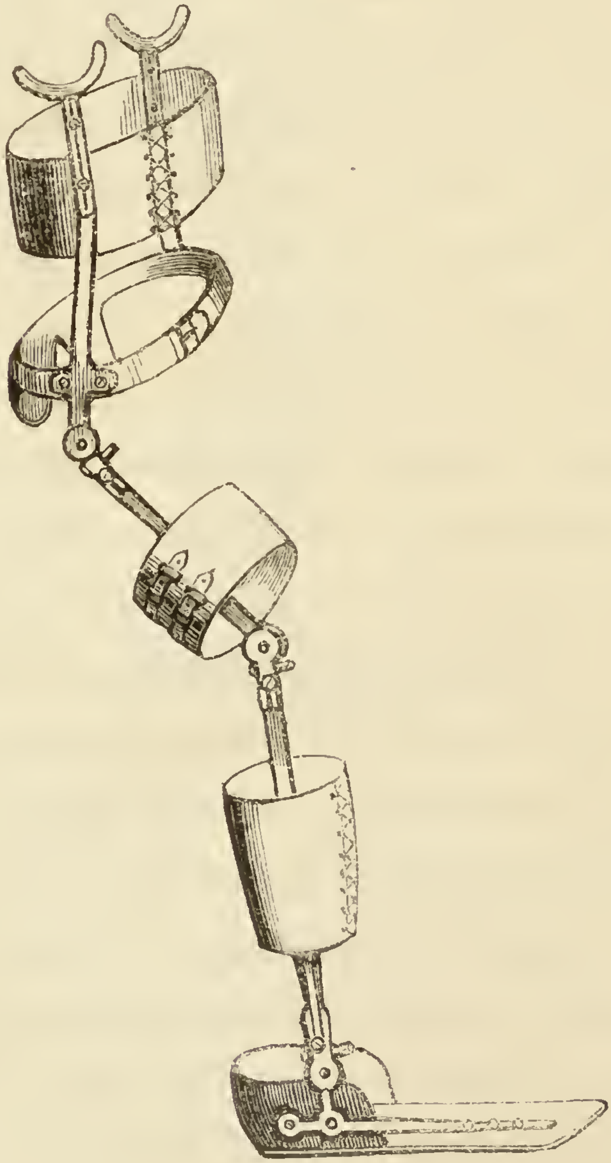
Another instrument, adopted in cases free from lateral deviation of the shaft of the thigh, consists of a metallic stem, which extends from the arm-pit to the sole of the boot, jointed at the knee, ankle, and hip. The latter joint is furnished with a powerful spring, formed on the gun-lock principle, and therefore constantly urging the thigh downwards. Of course the limb is secured to the lateral stem by thigh and calf troughs, the former passing in front of, the latter, behind the limb. There is also a pelvic band, which fastens the apparatus to the body.

Fig. 71.



An appliance which meets every requisition in cases of severe hip contraction, successfully combating and counteracting each abnormal force, with equal ease and certainty, deserves a more careful and detailed description. It is composed of a pelvic band, bearing two lateral uprights, upon which the arms rest, and from which strong laced-bands pass around the thorax. Two gluteal plates are placed at the lower edge of this pelvic belt: the second being intended to prevent the pelvic band from being horizontally rotated, or forced round upon the body, when the apparatus is extended; since the very contraction of the deformed limb induces a tendency to this mal-apropos proceeding. At the lateral margin of the belt, and in coincidence with the malformity, a powerful metal stem is screwed on, which contains two rack-and-pinion centres; one extending the thigh upon the body, the other forcing the femur outwards. Occasionally, a third ratchet, which acts horizontally, is introduced; but this is rarely necessary, as the combined actions of extension and abduction, if carefully managed, will also rotate the limb. The stem is prolonged to the heel of the boot, rack-and-pinion axes being placed at the knee and ankle, for the purpose of overcoming any contraction which may have taken place at those joints. The thigh and calf are held within the instrument in suitable troughs, the thigh trough being, as usual, fixed in front of the limb, that

Fig. 72.



for the calf, behind—thus they mutually counteract the flexion of the hip and knee.

This instrument, when managed with care, will effectually overcome each and every mechanical complication which can possibly be met with in contraction of the hip, knee, or ankle—no matter how severe. Sometimes it is also necessary to add a second rack-and-pinion joint at the knee, for the purpose of overcoming lateral displacement of the head of the tibia (on the principle laid down at page 171); and, in like manner, if varus exists, a modification of Scarpa's shoe (vide Fig. 19) renders this instrument capable of treating any description of "leg malformity" with complete success. There is one other motion necessary only, where actual luxation of the head of the femur has taken place, namely, that produced by an elongating screw placed at the thigh part of the apparatus (elongating the thigh on the trunk). All the advantages presented by the various orthopædic beds which are employed on the Continent are obtainable by this instrument, with the additional one, that the patient is able to take some slight amount of exercise upon crutches.

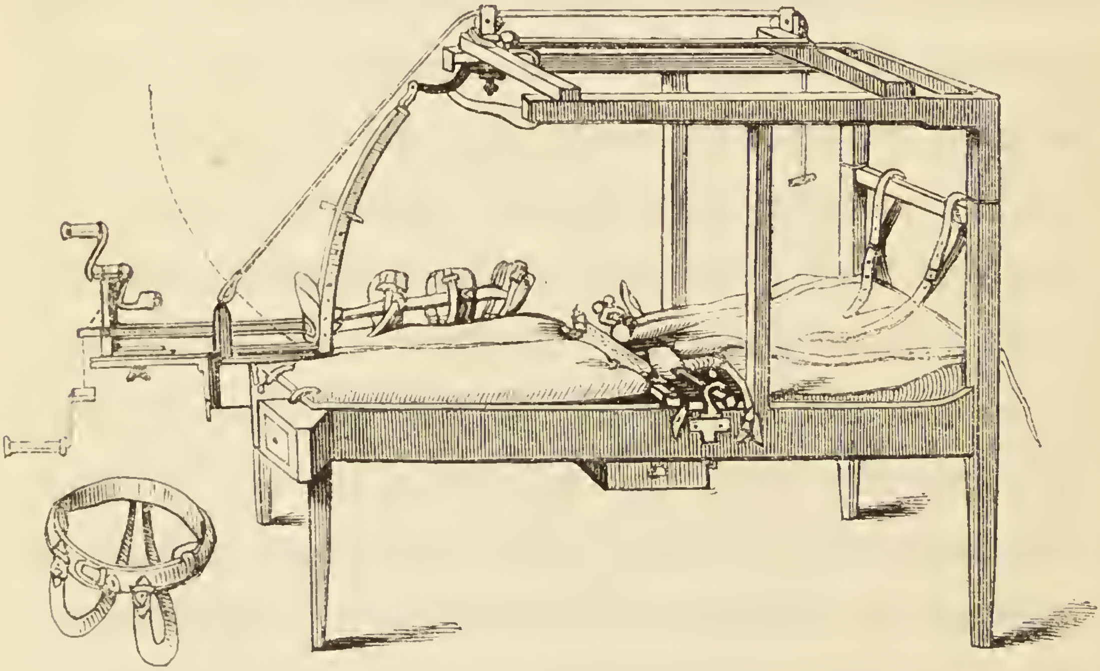
When in Wurtemberg, three years ago, I visited Dr. Heine's establishment, at Cannstadt, for the purpose of inspecting the various mechanical contrivances which are used in Germany for the treatment of deformities. This gentleman very politely gave me a printed description of his apparatus, in addition to an oral explanation of the various advantages which he attributed to it.

This apparatus is extremely ingenious, but so complex that I am unable to give a sufficient space for its detailed description in this work, the more especially since I fully believe that the portable instrument which I have but just described fulfils every condition of Dr. Heine's couch. In justice to his talented contrivance, however, I am bound to admit, that if the patient can submit, without loss of health, to the confinement entailed by his system, there can be but little doubt that the difficulties presented in "morbus coxarius" will be more easily overcome, without fear of using the various movements improperly, than by the portable instrument; since the management of the various axes in this last, calls for mechanical knowledge of no mean order; whereas in his bed, each action is suggested by the particular form which is assumed by the appliance, when fitted to the body of the patient.

Mr. Hugman, in a work recently published on "Diseases of the Hip-joint," is greatly in favour of Heine's couch, advancing very sound arguments to show its efficiency in severe cases, where all other contrivances are supposed to be inapplicable; but I cannot refrain from believing that, in all cases, the apparatus last figured coincides more perfectly, when in action, with the various centres of motion around which the limb plays in its malformed state; neither can it be objected to on the ground that it acts as a tight ligature around the limb, as the only points of *really necessary* pressure are, the front of the thigh and the back of the calf, the gluteal plates, the inner side of the foot, and that arm-piece which is *opposite* to the one in connexion with the leg mechanism. All other parts may be left tolerably loose, so that there is no actual ligature, a thing which cannot be asserted in favour of

Heine's leg-bands, for they must be very tightly adapted to the limb. Again, in Dr. Heine's apparatus, very little, if any, provision is made for those complications which are occasionally associated with contraction of the hip-joint—such as flexion of the knee to a righ angle, lateral displacement of the head of the tibia, &c. &c. I give a sketch of Dr. Heine's couch, in order that the two apparatuses may be contrasted by my professional readers.

Fig. 73.



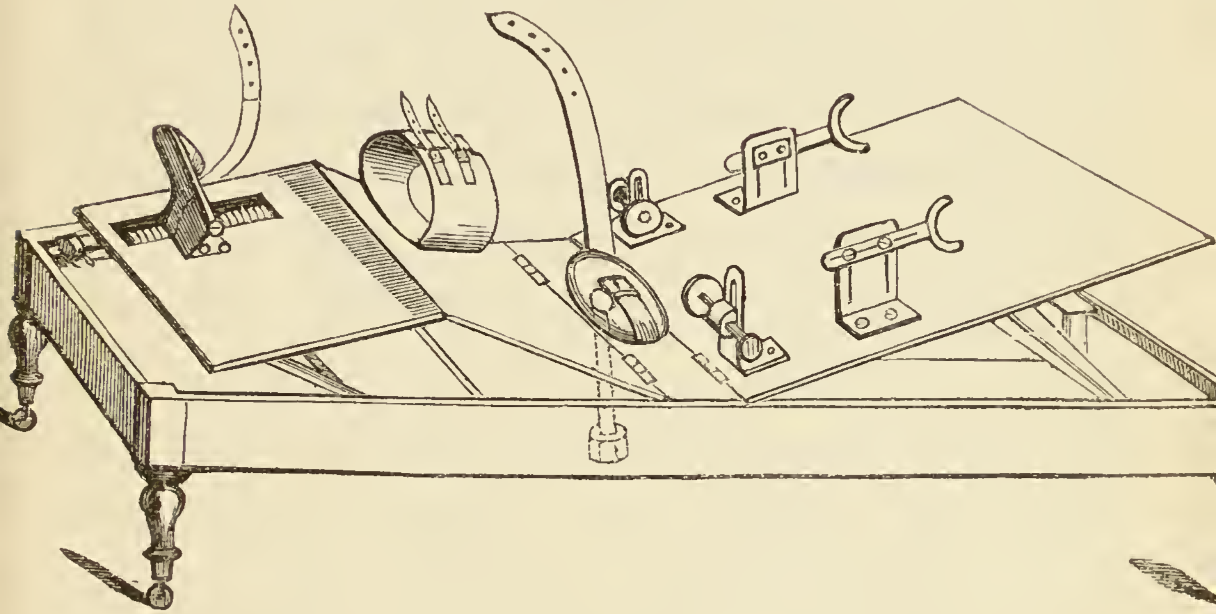
A well known apparatus, called a "prone couch," is often effective in simple cases of "shortening of the hip-joint," as, from its flexed condition, the weight of the limb facilitates elongation; however, it is objectionable on mechanical grounds, because the thigh and trunk are constantly kept in a bent position, thus occasioning contraction of the flexors. This plan is of far greater mechanical utility if adopted for the purpose of obtaining rest when the early symptoms of hip disease are present, although, under these circumstances even, I consider the plan proposed by Sir Benjamin Brodie to be infinitely superior.

This consists in carefully adapting a thick piece of leather to the pelvis and thigh, the leather being applied while *wet* and flexible, and allowed to dry and harden to the shape of the body. So perfect is it, indeed, that it even exercises a control over the involuntary muscular motion which is frequently observed in these cases, and which sometimes induces sudden movement of, and disturbance in, the joint. I have frequently applied these splints by the direction of Sir B. Brodie, Messrs. Fergusson, Quain, H. C. Johnson, Hilton, Erichsen, &c., and invariably found that the limb was held in a state of perfect rest by means of them.

The best modifications of the principles laid down by Heine are to be found in a couch of the following construction. It consists of a double inclined plane, and in order that the objection so constantly urged against this compound inclination—viz., that it produces great pressure upon the nates — may be avoided, the glutei rest upon a padded plate, which can be uplifted by a perpendicular screw, passing upwards from under the centre of the couch. Two pads are fixed by long horizontal screws at each side of the couch, their office being to grasp the sides of the pelvis laterally, and in this way afford a fixed point of action for the extending mechanism. A strong padded band is placed over the thigh on the outer side of the limb affected, and in connexion with the plane, another passing around the leg. As the angles of the plane are varied, so does the thigh become extended upon the trunk; and as the pelvis can be uplifted at the same time, the joint may be readily restored to a normal position. There is also an extending metal stem, to promote lengthening of the limb.

Various straps were fixed to the frame, with the intent that the pelvis might be secured firmly to it, the arm-pits likewise being received by sliding and thickly padded metal crutches.

FIG. 74.

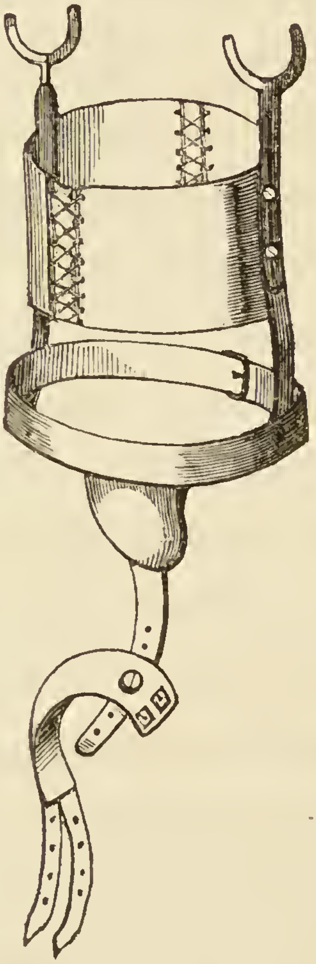


Sometimes a contraction of the hip-joint is at once overcome by placing the patient under chloroform, and then breaking away the adhesions around the joint by violence. I contrived an instrument, at Mr. Brodhurst's suggestion, which is well calculated to effect this end, and another for maintaining a tolerably constant exercise of the joint, after the completion of the previous operation. The former of these contrivances consists of an ordinary "easy-chair," to the seat of which a strong and well padded band is affixed, which, after passing over the pelvis, is fastened to the opposite side. At the back of the chair, near its upper margin, a powerful pulley is secured, through which a cord passes, terminating in a padded thigh-band. The surgeon takes a position in front of the patient, and violently flexes the thigh by pulling the cord. Having allowed the limb to rest for a few days after this has been accomplished, the next apparatus employed consists of a strong wooden seat with a pelvic strap. Another strap passes under the perineum, which is secured to the external lateral margin of the board. A pulley is screwed into the ceiling, through which a rope runs, attached to a thigh-band enclosing the limb by one end, and held by the patient at the other. An uplifting of the thigh follows when this rope is pulled, and if the thigh-band is also furnished with another rope, passing through a pulley fixed in the ground, alternate flexion and extension is readily set up, ultimately securing perfect mobility in the joint.

Bonnet suggests a somewhat similar apparatus, but employs a handkerchief to hold the thigh, which, I know from experience, is incapable of fulfilling the object for which it is proposed.

An instrument occasionally employed for cases of contracted hip is formed as follows:—It consists of a pelvic band bearing two lateral uprights, one of which has a perpendicular spring at its lower border, which supports a bandage intended to embrace the knee. My reasons for thinking that this instrument is extremely ill-devised are, firstly, that the posterior stem must be constantly in the way whenever the patient attempts to sit down; secondly, that the lever which is applied for the purpose of extending the thigh would prove absolutely useless in cases of rectangular contraction, for it would be far more likely to turn the apparatus round upon the body, than to diminish the contraction; thirdly, that the lever can rarely, if ever, be kept in the mesial line of the thigh, where it undoubtedly should be, in order that effective mechanical traction may be given. I would not have mentioned this instrument, had I not found that it has been strongly recommended to the surgical profession as an efficient instead of an objectionable agent in the mechanical treatment of contractions of the hip-joint. The gentleman who devised the apparatus may be a good surgeon—I am quite sure that he must be a very poor mechanist.

Fig. 75.



This apparatus completes the series of those instruments which are most commonly and successfully used for the mechanical treatment of every variety of distortion met with in the lower limb. Although they might seem to be unnecessarily numerous, if brought before the notice of any person who was ignorant of the great variety existing in deformities, yet I feel confident, that those surgeons who may feel interested in perusing these pages will allow me the merit of having given as moderate a number of instruments as is consistent with the object for which the work was undertaken—viz., to enable the surgeon to select, from the most approved apparatuses of the present day, that instrument which he may consider most suited to the exigencies of the particular case in which he happens to be interested; and likewise, in order that gentlemen who are practising in India, the colonies, &c., may have a tolerably clear guide, should they endeavour to have their apparatuses constructed upon the spot. Had I desired to make a "big book," I might easily have done so, not only by giving *prolix* instead of *concise* descriptions of such appliances as are figured in the preceding pages, but, in addition, by enumerating at least three times as many varieties of the different instruments which have been constructed by me, from time to time. I have carefully abstained, however, from representing any, save those which have received the sanction and approval of the most distinguished members of the medical profession, and been adopted in their practice, private as well as public,

I trust that I shall be pardoned, when I reiterate that which I have so constantly avowed throughout the preceding pages—viz., that unless mechanical appliances are constructed with a due regard to the anatomical and mathematical conditions of malformities, they will inevitably give dissatisfaction to all parties when applied, to say nothing of the increased amount of trouble, loss of credit, inconvenience, and expense, entailed upon the surgeon, mechanist, and patient, respectively.

It is impossible to lay down fixed rules for guidance in the selection of particular contrivances, since this can only be determined by the distinctive characters and exigencies of the case under treatment.

The introduction of tenotomy has conferred a boon of incalculable value upon all parties interested in the treatment of deformities of the extremities, and mechanists have strained every nerve to take advantage of the increased facilities afforded to the curative powers of their appliances, by the general adoption of this practice in varus and other malformities, in which the contracted state of tendons offers the chief obstacle to mechanical treatment—an obstacle which can only be removed, in the majority of cases, by the skilfully applied knife of the surgeon in attendance on the patient, although it is useless to conceal or dispute the fact that the knife has been occasionally resorted to, when the malformity was so slight as to be just as amenable to mechanical treatment *pure et simple*, provided that the apparatus employed was constructed on sound and philosophic principles. Nevertheless, even in this case, ultimate harm is seldom done, although the patient's recovery may be somewhat retarded by the blunder.

Even in the teeth of the fact, that the various members of the house to which I belong have, for upwards of one hundred years, been entrusted by many of the most distinguished surgeons of past generations, with the entire management of such cases as required mechanical treatment, I can conscientiously aver that it is a source of unmixed and daily gratification to me, that I live in an age in which it is no longer considered as incompatible with the professional dignity of the surgeon, that he should combine his talent and acquirements with those of the mechanist, when engaged in the treatment of mechanical distortions; for I am well assured that the interests both of science and humanity are better forwarded by this combination of action in unity of purpose, than they would be if cared for by either *singly.* Since the leading surgeons of our large metropolitan hospitals have taken a more active part in the conduct of these cases, since the mechanist has been assisted and encouraged by perceiving that his efforts and talents are better appreciated, numbers of restorations to normal form have been effected, in cases which would formerly have been looked upon as hopeless.

APPENDIX.

As many of the terms used in the preceding pages are of a purely technical character, I think it expedient to give such definitions of their significations as will render them intelligible to non-professional readers.

ABNORMAL.—That which differs from the ordinary plan, rule, or condition.

ABDUCTION.—Used, technically, to denote the withdrawing outwards of any portion of the human frame from its perpendicular centre, or "mesial line."

ADDUCTION.—The reverse of abduction, *i. e.* the foot, &c., when drawn outwards, is said to be *abducted;* when inwards, *adducted.*

ACHILLIS (tendo).—The powerful tendon uniting the calcaneus, or heel-bone, to the muscles of the calf. When these muscles are contracted, as in "equinus," the surgical division of this tendon facilitates the reduction of the foot into its original position. Thilenius of Frankfort was the first person who divided this tendon; thereby founding the modern treatment of deformities, so widely extended by Stromeyer, Delpech, &c.

ANNULUS.—A ring; the term employed to designate the form of joint used in the instrument for bunion, Fig. 2; also that for knock-knee, Fig. 54.

ANGULAR.—When two lines incline to one another and meet, not being in the same straight line, they are in an angular position; *e.g.* the leg and thigh, when the knee is bent. All joints are angular when at all bent, and the accurate determination of the degree of a contracted part's angularity, greatly facilitates the correct construction of the apparatus by which it is to be rectified.

ANTERIOR.—The front or foremost part of that which is under discussion.

APEX.—When two inclined lines meet, the point of junction is termed "the apex;" *e. g.* the knee, when bent, is the apex of the leg and thigh. Properly speaking, this term is restricted to the highest point in a triangle, pyramid, cone, mountain, &c.

ARTICULATION.—A joint. The opposing surfaces of any two bones forming a joint are termed "articular surfaces."

ASTRAGALUS (or "Talus").—The uppermost bone, or keystone, of the arch of the foot, which moves backwards and forwards upon the leg-bone.

AXIS.—The point or centre around which a body moves when in action; *e.g.* in bending the arm the elbow-joint becomes an axis around which the motion takes place.

BICEPS FLEXOR CRURIS.—A muscle of the thigh, the tendon of which forms the outer ham-string, and is generally divided in severe cases of contracted knee. It powerfully contributes to the bending of the knee-joint.

BIFURCATE.—When a single stem suddenly divides into two, as in a pitchfork, it is said to bifurcate. In Fig. 46, the stem which supports the heel-plate bifurcates from the one influencing the anterior two-thirds of the foot.

CALCANEUS (or Os Calcis).—The heel-bone. Also a term used to designate that kind of foot deformity which is distinguished by a permanent falling of the heel.

CONDYLES.—The bony prominences usually known as knuckles; especially used to denote those in which the thigh-bone terminates in the knee-joint.

CONTRACTION.—A drawing together of two bodies; generally made use of by me to signify unnatural and permanent approximations of parts.

CUBOID BONE.—That bone in the foot which forms the keystone to the arch of the instep, and becomes prominent when the front part of the foot is turned inwards, as in club-foot. It is supposed to exercise so powerful an influence in retarding the cure of severe cases of this deformity, that Mr. Solly recommends its surgical removal. I constructed the mechanical appliances for a case in which this operation was performed, and the improvement was satisfactorily rapid, after Mr. Solly had diminished the mechanical resistance offered by the crown, or keystone, of the tarsal arch. Unless proper precaution be taken, the skin covering this bone frequently becomes broken and sore, while club-foot is being treated by an ordinary "Scarpa's Shoe."

EQUINUS.—That kind of club-foot in which the heel is uplifted, and the patient compelled to walk upon his toes.

EVERSION.—When either margin of the sole of the foot is uplifted from the ground, it is, technically, said to be "everted."

EXTENSION.—A stretching out. Here it generally means the separation of parts unduly approximated, as in cases of knee-contraction, &c.

FEMUR.—The thigh-bone; the longest bone in the body in MAN, and man alone.

FIBULA.—The thinnest of the two leg-bones. It is the outermost of them.

FLEXION.—The act of bending; especially applied to the bending of articular joints.

FREE JOINTS.—When two levers are fastened together by a simple hinge, they are said to be connected by a "free-joint;" that is to say, one which may be bent forwards and backwards at pleasure.

FULCRUM.—The point against which a lever gets its resistance, when exerting its power on some other power.

GASTROCNEMIUS.—The great muscle of the calf.

GENUFLEXION.—A bending of the knee-joint.

GENU VALGUM.—Knock-knees.

GINGLYMOID.—Resembling a "hinge." The knee and many other joints move in this manner.

INFERIOR.—The lower surface of anything is surgically known as the "inferior" surface, &c.

INVERSION.—A turning inwards, or towards the mesial line; *e.g.* the knee is inverted in knock-knee; the sole of the foot in varus.

ISCHIUM.—That part of the hip-bone upon which we rest when sitting. The tuberosity of the ischium is a hard bony prominence, the lowest point in the pelvis, and is made use of as a mechanical *point de resistance* in all cases where the leg requires to be assisted by an apparatus in supporting the weight of the body.

KNEE-CAP.—A band of strong leather which binds down the knee into its proper place in various mechanical appliances intended for the cure of deformities of the lower limb.

LATERAL.—That which is at the side. Side-long, when applied to "motion."

LEVER.—A mechanical power. Levers are generally divided into three kinds. In the first, the resistance to be overcome is placed beyond the point against which the force is exercised: thus in the apparatus for club-foot shown in Fig. 17, the applied power is situated at the ratchet-joint; the resistance or "fulcrum" against the outer side of the heel and instep;

and the force to be overcome is the deformed foot. In the second order, the resistance is placed within the point against which the force is exercised: thus in the apparatus, Fig. 10, the power is at the calf-band; the fulcrum, against the under surface of the toes; and the force to be overcome, the uplifted instep and heel. In the third order, the power employed is placed between the fulcrum, or point against which it is to be exercised, and the resistance to be overcome: thus in the contracted knee instrument, Fig. 60, the power is at the rack and pinion-joint; the fulcrum, at the thigh-band; and the force to be overcome is the contracted leg. Every stem or bar employed in the construction of anatomical appliances is a lever of one or other of these three kinds, and rotates on its own axis: moreover, as their mechanical force can be easily calculated, it is very important that the power employed should be so economized that it will overcome the deformity without producing more pressure, or resistance, against the surface of the limb than may be absolutely necessary.

LUXATION.—A dislocation (putting out of joint) of a bone from its proper position in any joint by which it may be connected to another bone; whether it be removal of a projecting head of one bone from the recipient cavity of another, as in "dislocated hip," or mere malposition of two plane surfaces, as in dislocation of the collar-bone.

MALLEOLI.—The two bony prominences situated on the outer and inner sides of the ankle-joint. They are distinguished as the external malleolus, and the internal malleolus: the former belonging to the small bone of the leg (fibula), the latter to the large one (tibia). Conjoined they form a cavity which receives the astragalus, the uppermost bone of the foot.

MESIAL.—That which is in the middle of anything. The vertical line which passes down the centre of man's body.

METATARSUS.—Five long bones in the foot, which connect the tarsus, or instep, with the toes.

NAVICULAR BONE.—The scaphoid, one of the bones of the instep, is often so called. It derives both names from a fancied resemblance to a boat. The lateral movement of this bone on the astragalus is said to account for that inversion of the front part of the foot which forms a feature in varus, or club-foot proper.

ORTHOPÆDY.—The name given to that branch of Surgical Science, which especially relates to the treatment and cure of deformities of the human body.

PATELLA.—The little bone commonly known as the "knee-cap."

PELVIS.—The aggregated bones which compose the hips and that portion of the trunk situated below the waist.

PERIPHERY.—The line which bounds a circle—the "circumference." The line bounding the arc of a semicircle is also called a periphery.

PERONEI.—Certain muscles connecting the fibula or smaller of the two leg-bones with the foot, and acting mechanically, by producing that flatness of the foot which is so necessary in walking. When these muscles are contracted, the sole of the foot becomes inverted, whereby a deformity named "valgus" is established.

PHALANGES.—The bones of the toes or fingers. They are distinguished as proximate, medial, and distal—first, second, and third joints.

PINION.—A description of screw used in anatomical appliances, which is so constructed as to enter the teeth of a joint, the surface of which is, of course, adapted for its reception. In almost all the joints alluded to in the preceding pages, the moving power consists of a pinion fixed to one portion of the joint, acting against a ratchet placed in the other piece.

Plaster of Paris Casts.—Models of deformities are frequently obtained in this material. A recipe for taking them is given in another part of this work.

Plantar Arches.—The bony arches at the sole of the foot are thus named.

Popliteus.—A muscle placed in the "ham," or back part of the knee, which extends between the leg and thigh, and aids in uniting them.

Posterior.—The hindmost or back point, or surface, presented by a part under inspection.

Rack and Pinion.—The toothed or dentated end of a lever is termed the rack; and the screw which enters and gives motion to it is called the pinion.

Ratchet-joint.—A mechanical arrangement by which two levers are gradually flexed or extended, deriving its name from one lever being furnished with a toothed extremity, whilst the other possesses a horizontal screw fitting into it.

Radius.—The rotary bone of the fore-arm, situated on the *thumb-side* of the limb.

Rectangular.—That which is bent to a right angle.

Right Angle.—When a straight line standing on another straight line makes the adjacent angles equal to one another, each of these angles is called a right angle; and the straight line, which stands upon the other, is called a perpendicular to it. Every right angle measures 90 degrees. Supposing an orange to be divided into four quarters, each quarter would be a right angle at the pith.

Rotation.—The turning round of a body, whether on its own axis or around some other body.

Scaphoid.—*Vide* "Navicular-bone."

Screw.—One of the principal mechanical powers. There is an almost endless variety of screws. It is an inclined plane twisted round a cylinder.

Semimembranosus.—A muscle of the thigh and pelvis, the tendon of which forms part of the inner hamstring.

Semitendinosus.—Another muscle belonging to the same part, also a component of the inner hamstring. It is remarkable for the length of its tendon. The hamstrings are divided in severe cases of knee contraction.

Socket.—A cup or depression in one body, in which a part of some other body works.

Soleus.—A large, deeply-seated muscle at the back of the leg. It contributes, with the gastrocnemius, to form the tendo Achillis.

Stop-joints.—Joints the free action of which is governed by a stop or check.

Superficies.—A superficies is that which has only length and breadth. It answers to what is commonly termed "surface."

Talipes.—The generic name of club-foot. It is divided into three species:—1. Talipes Valgus, or Flat-foot; 2. Talipes Equinus, or "Horse-heel;" 3. Talipes Varus, or "Club-foot proper." Each of these occasionally forms combination with the others.

Tangent.—One body touching another becomes a tangent to it.

Tangential Screw.—A name given to the pinion of a rack and pinion joint. In Germany this is called an endless screw, from its being employed to turn serrated, or toothed wheels on their axes. The reason for its being termed tangential is explained by the definition given to "Tangent."

Tarsus.—The aggregated bones of the instep and heel, seven in number.

TENOTOMY.—The operation of dividing tendons for the purpose of aiding the mechanical cure of deformities. This is one of the great improvements of modern surgical science.

TIBIA.—The large bone of the leg.

TIBIALES.—Two muscles of the leg, the tendons of which are inserted into the tarsus. The Tibialis Anticus flexes the tarsus upon the leg. The Tibialis Posticus extends it, and directly antagonizes the former muscles. Acting in conjunction, they direct the foot inwards; hence both are generally divided in severe cases of varus.

TORSION.—A twisting or screwing round of a part.

TROCHANTERS.—Generally applied to two large outgrowths, or processes of bone at the upper part of the thigh bone, which give attachment to powerful muscles. The greater is called the trochanter major; the lesser, the trochanter minor.

ULNA.—The fixed bone of the fore-arm, which forms part of the elbow-joint. The radius rotates round it.

VALGUS—FLAT-FOOT.—That kind of club-foot in which the sole of the foot is directed outwards, and the inner ankle approximated to the ground.

VARUS.—Club-foot proper, the opposite of valgus. In this variety the patient walks on the outer side of the foot.

VERTICAL.—Perpendicular, upright.

DIRECTIONS FOR TAKING CASTS.

Having taken as much fine plaster of Paris as will amply suffice for the purpose for which it is required, mix it thoroughly and gradually with water, until it shall have acquired the consistency of thick cream. Having previously well oiled the parts which you wish to have a model of, apply the wet plaster around them, until they are completely covered by a mould, or matrix, of at least an inch in thickness. When this begins to *set*, a point easily ascertained by the plaster becoming warm and hard, it must be taken off, and allowed to harden for two or three hours ; it should then be immersed in cold water for one hour, taken out, and be well brushed over (especially on the inside) with boiling oil. It will now be quite ready for use as a mould.

When the mould cannot be taken off in one piece, and this is generally the case, always indeed where the part is multi-angular, as a hand, foot, trunk, &c., a string should be so placed *on* the part to be copied (it can always be fixed by a little gum,) as to be readily made to cut its way out, just like a string cuts soap, as soon as the plaster of Paris begins to set, and in this way to divide the matrix into two or more pieces. When the hand is taken, the string should be gummed on each side of the fore-arm, and pass over and between each separate finger, the ends being left hanging loose at the elbow. When it is the foot, the string should pass down each side of the leg ; behind the ankle, and over the toes. When the trunk, two or more bits of string must be used on each side.

The mould should be very carefully packed, the pieces being kept separate by sawdust and cotton wool. On receiving them, I shall be able to get the necessary cast made.

THE END.

Also, by the same Author,

ON ARTIFICIAL LIMBS,

THEIR

CONSTRUCTION AND APPLICATION.

From Her Majesty the Queen.

BUCKINGHAM PALACE, *September* 5, 1855.

SIR,—I have the honour to acknowledge the receipt of your Letter of the 3rd inst. accompanying your work upon Artificial Limbs, which I have laid before the Queen, and which Her Majesty has been graciously pleased to accept.

I am, Sir,
Your obedient, humble servant,
C. B. PHIPPS.

To Mr. Bigg.

LANCET, *August* 4, 1855.

THIS work is one of the emanations arising out of the present unhappy war. Many of our soldiers and sailors have escaped death, but have returned with the loss of a limb, which will not only unfit them for future service, but must also render them to a certain extent incompetent to perform the necessary requirements of life. Surely time passed in studying the best artificial means of supplying a substitute for the lost part is a just tribute to those brave fellows who have fallen maimed in defence of their country's honour.

The author has done well to publish his experience at the present time. He teaches the scientific principles upon which the different parts should be manufactured, so that, in the hands of a competent mechanician, the artificial limb may not only prove pleasing to the eye, but useful to the wearer.

Some excellent remarks occur upon the form of stump best suited to the adaptation of artificial means. Mr. Bigg says, in reference to amputation of the arm, "The best shape a stump above elbow can possibly possess is when it *gradually* tapers from the shoulder to its end, leaving a rounded surface at its inferior extremity;" also that a "stump much thickened at its end is a great trouble to the arm-maker."

A chapter upon the instruments for artificial hands is particularly interesting, enabling a person to write, shoot, drive, &c., with extraordinary facility; that also upon the mechanism of artificial joints is highly instructive, and proves that the author is master of his subject. There are, however, many difficulties to overcome; for instance—

"In the form of the knee-joint the motion is not, as would at first be imagined, derivable from a point in the middle of the knee, but has its existence at least half an inch behind such supposed centre, the action resembling a hinge, with the patella, or knee-cap, covering the open or basal extremity. Thus, anatomically and osteologically, the centre is not in the place it would appear to be, when the leg is only superficially observed or considered in an artistic light."

The book is very properly addressed to the medical profession, both civil and military, and is well worthy attentive perusal.

Medical Times and Gazette, *August* 25, 1855.

Mr. H. Heather Bigg is, we believe, the present representative of a firm that has long enjoyed considerable reputation for the excellence of their workmanship, and for the ingenuity displayed in the construction of mechanical apparatus for the relief of deformity or mutilation of the body. In the pamphlet before us, he describes the various kinds of artificial legs and arms, from the simple wooden leg of the Greenwich Pensioner, or the hook by which a one-armed labourer may lift a wheelbarrow, to the finished limbs, with their apparatus of joints and springs, which almost perfectly imitate the form and gait of the natural. Imitate, do we say? As for artificial hands, our author plainly intimates that many a man who has lost one of his two beefy fists, may derive no small consolation for his loss from the exquisite symmetry which the mechanism can impart to the artificial substitute; although as, unfortunately, no artificial means have been discovered which can compensate for the softness and warmth of nature, Mr. Bigg naïvely advises that, however pretty the artificial limb may be to the eye, yet that the patient should always "present the natural hand, whenever it is likely to be touched." This is very judicious advice; a squeeze from a false hand would be a damper.

The surgeon who desires to procure an artificial limb for a patient, may consult Mr. Bigg's pamphlet with advantage.

MEDICAL CIRCULAR, *August* 22, 1855.

WE hail this brochure with much satisfaction. Our surprise is that a work of this kind, explaining the various forms of mechanism employed as substitutes for lost limbs, and the principles of their application, has not long ago been offered to the profession. Every medical man must have felt at some time or other the necessity of possessing such information as this book conveys. In our view it is a part—though a subordinate one—of the surgical art, and deserves to be studied and understood by the skilful surgeon. The comfort of a patient depends upon the construction and accuracy of adaptation of his wooden leg or arm; how desirable, therefore, it is, that the Surgeon should have a competent knowledge of this branch of art. Why not be as well acquainted with the mechanism of these instruments as of others for the relief of spinal curvature or bent legs?

At the present time, when so many of our fellow-countrymen are returning from the Crimea with loss of limb, this work comes before us with peculiar appositeness. The profession are indebted to Mr. Bigg for the timeliness, not less than the usefulness, of his publication, and, without wishing more misfortunes to our brave troops than the severe trials of war may necessitate, we hope that he may have that full share of public patronage which he deserves.

DUBLIN MEDICAL PRESS, *October* 24, 1855.

THIS little book, of 107 pages, consists of two parts and an appendix. The first treats of the mechanism for the formation and adjustment of artificial limbs for stumps after amputations above and below the knee. The second part is devoted to the discussion of the best form and application of artificial arms, fore-arms, and fingers. The appendix is made up of the mechanical treatment of the varieties of talipes or club-foot, deformity of the legs, curvature of the spine, hernia, varicose veins, prolapsus uteri, pendulous abdomen, prolapsus ani, &c. &c. The author has bestowed very great pains on the work, and from the numerous diagrams has made the mechanical contrivances very clear: every artificial extremity appears to be admirable in theory and ingenious in practice.

ART JOURNAL, *Oct.* 1855.

IT is among the peculiarities of the times—and, perhaps, one of the most promising "signs"—that the more intelligent members of several trades, occupations, and professions are publishing the result of their experience. No doubt their principal purpose is to advance their own interests; but, in so doing, they contribute largely to public information: it is an obvious truism that those who know most can teach us most, although it is not often that we find such teachers: men are far too apt to keep their knowledge to themselves. Mr. Bigg is an eminent "surgical mechanician," who has been long employed by the several government institutions—such as Chelsea and Greenwich—and by all the great hospitals in London. His repute is, therefore, well established. His book is profusely illustrated by explanatory woodcuts; and it treats upon every branch of the art which he professes—one that, now-a-days, more especially demands attention from all classes; for, unhappily, this art is likely to be the minister of comfort to many thousands. The subject is treated with great clearness and simplicity: it does not, indeed, enable a patient to be his own "mechanician," but it instructs him how to make the best of a bad case; and to lessen, as far as possible, the grievance by which he has been afflicted. A book of this kind, therefore, at such a moment, cannot fail to be considered a public benefaction; and to refer to it such persons as need its aid is a public duty.

ERA, *Sept.* 23, 1855.

MR. BIGG, who is well known to the faculty as an anatomical mechanician, has published a work of great value, especially at the present time. The requirements of his delicate and useful art have of course increased a thousand-fold during the present war, and we venture to say that neither the professional nor ordinary reader can peruse these pages without discovering that their author is scientific, inventive, and thoroughly master of the details of our bodily construction. In Mr. Bigg's inventions the action of the living limb is closely followed, and its loss as nearly supplied by mechanical apparatus as the closest study of the subject could enable the intelligent mechanician to effect. Extraordinary as are the means used for enabling the unfortunate person who has been deprived of one or both legs still to place a firm foot on the ground, we are nevertheless even more surprised at the skill displayed in giving as useful a hand, after the loss of that natural member. However, our best and confident recommendation of this admirable little work will be most forcibly expressed, perhaps, by our saying that Mr. Bigg has not overstated his pretensions in these remarks, which we quote from his preface:—

"Few persons, unless made acquainted by practical experience with the difficulty of successfully imitating the mechanical action of a leg or an arm, can be at all aware of the extreme painstaking and care with which every movement simulated must be studied. In ordinary contrivance, it is simply requisite to consider the end to be attained, and then render the means subservient, but where the needed apparatus is of an anatomical character, and must strictly be conformed to certain symmetrical proportions, sometimes at apparent mechanical variance with the point to be accomplished, the difficulty of construction is considerably increased. To prove this, it is only necessary to examine a natural leg, and suppose its shape superficially followed in the formation of a mechanical substitute, the result of which would be that when needed for use, instead of offering support capable of sustaining the *weight* of the human body, it would yield in its joints the moment such weight was applied, the reason being that the *actual* centres of motion differ from their *apparent* external position.

"In the form of the knee-joint, for instance, the motion is not, as would at first be imagined, derivable from a point in the middle of the knee, but has its existence at least half an inch behind such supposed centre, the action resembling a hinge, with the patella, or knee-cap, covering the open or basal extremity. Thus, anatomically and osteologically, the centre is not in the place it would appear to be, when the leg is only superficially observed or considered in an artistic light."

WEEKLY TIMES, *August* 5, 1855.

THIS little treatise from the pen of an ingenious and practical mechanist is very suitable at this time, when the fatal conflict in the Crimea sends home limbless so many men, otherwise in the prime and vigour of their existence. The advance made in substitutions for the loss of the natural limbs is something wonderful, from the walnut-tree pin with which the old Admiral or General formerly stumped into a drawing-room, to the elegant substitute, full of ingenious mechanism, which Mr. Bigg supplies to his patients. In hands and arms, contrivances equally admirable enable the possessor to supply the loss of the natural limbs; and by which the patient can lift weights, feed himself, and even write, and, what is scarcely indesirable, still wage battle. Amongst numerous diagrams is one of an officer in the Hudson's Bay Company, who, having lost his hand and arm, was supplied with a mechanical one with a dagger attached to it, and with which he still pursued his dangerous avocation in the wilds of North America.

The little book is very clearly written, and cannot but be highly acceptable to all who may have been deprived of their limbs; and they will be surprised to find how greatly science and mechanism can relieve their misfortunes.

London Evening News, *Sept.* 3, 1855.

This, although a curious book, is on a very interesting subject, and one which every one having relatives limbless, either at home or elsewhere, should immediately enlighten themselves on. The progress which has been made in later years in substitutions for natural limbs, is wonderful—from the walnut-tree pin with which the old Admiral formerly stumped into the room, to the elegant substitute which Mr. Bigg supplies to his patient. Contrivances, equally admirable, in hands and arms, enable the possessor to lift weights, feed himself, write, and even wage battle, so that many a handless Crimean hero may yet return to the help of our almost perishing army. Amongst numerous diagrams we observe that of an officer in the Hudson's Bay Company. who, having lost his hand and arm, was supplied with a mechanical one, with a dagger attached to it, and with which he still pursued his dangerous avocations in the wilds of North America. The writing is clear and forcible; and the facts revealed will astonish and please those who may have been so unfortunate as to have lost a limb.

Morning Post, *April* 3rd, 1856.

Her Majesty's Benevolence.—Amongst the many acts of kindness which her Majesty has displayed towards her wounded soldiers from the Crimea, one of the latest is perhaps the most considerate. The public will be gratified to learn that, at her own private expense, the Queen has commanded artificial legs to be constructed for the following men, whose severe mutilation attracted her Majesty's notice during the recent royal visits to the hospitals of Portsmouth and Chatham:—Corporal Burland, John Connery, Francis Ready, Samuel Huson, Corporal Marks, and Patrick Kenny. With the exception of Kenny and Huson, who still each retain one leg, all these poor fellows had lost both limbs. They are now, however, by her Majesty's bounty, enabled to walk as well as heretofore. In addition to the above-mentioned, the Queen has caused George Greenway, William Boyce, and Henry Ashforth to be supplied with artificial arms. The first man had his arm shot away just below the shoulder; the second lost both arms by the explosion of a shell, whilst he was in the act of lifting a pickaxe above his head; and the third lost his arm below the elbow. A soldier named Edward Sharpe has also been presented with a spinal apparatus, his vertebræ having been injured so severely by a spent ball as to prevent the poor fellow standing erect. By the aid of the instrument employed, he now walks perfectly upright with ease. All these cases were of extreme severity, and, without the exercise of her Majesty's kindly aid, the wounded men would have been unable to have procured the delicate mechanism which has now rendered them capable of fulfilling any employment suitable to their condition. The whole of these appliances have been furnished by Mr. Heather Bigg, the anatomical mechanician of Leicester-square.

Daily News, *April* 3, 1856.

Her Majesty's Benevolence.—The Queen has commanded Mr. Heather Bigg, of 29, Leicester-square, the anatomical mechanician, to construct artificial legs for the following men, whose severe mutilation attracted her Majesty's notice during her recent visits to the hospitals of Portsmouth and Chatham—viz,, Corporal Burland, John Connery, Francis Ready, Samuel Huson, Corporal Marks, and Patrick Kenny. With the exception of Kenny and Huson, who still retain each one leg, all these poor fellows had lost both legs. They are now, however, by her Majesty's bounty, enabled to walk as heretofore. In addition to these, the Queen requested Mr. Bigg to supply — Greenway, William Boyce, and Henry Ashforth, with artificial arms. The first man had his arm shot away just below the shoulder, the second lost both arms by the explosion of a shell, whilst he was in the act of lifting a pickaxe above his head, and the third lost his arm below the elbow. A man named Edward Sharpe has also been presented with a spinal apparatus, his vertebræ having been injured so severely by a spent ball as to prevent the poor fellow standing erect. By the aid of the spinal instrument employed, he now walks perfectly upright with ease. All these cases were of extreme severity; and without the exercise of her Majesty's kindly aid, the wounded men would have been unable to procure the delicate mechanism they required. They are now competent to follow a variety of light occupations, for which otherwise they would have been disqualified.

Morning Chronicle, *April 3rd*, 1856.

Her Majesty's Benevolence.—Amongst the numerous acts of kindness displayed by her Majesty towards the wounded soldiers from the Crimea, the public will be gratified to learn that, at her own private expense, the Queen has commanded Mr. Heather Bigg, of 29, Leicester-square, the well-known anatomical mechanician, to construct artificial legs for the following men, whose severe mutilation attracted her Majesty's notice during her recent visit to the hospitals of Portsmouth and Chatham :—Corporal Burland, John Connery, Francis Ready, Samuel Huson, Corporal Marks, and Patrick Kenny. With the exception of Kenny and Huson, who still retain each one leg, all these poor fellows had lost both legs; they are now, however, by her Majesty's bounty, enabled to walk as well as heretofore. In addition to these, the Queen requested Mr. Bigg to supply — Greenway, William Boyce, and Henry Ashforth, with artificial arms. The first man had his arms shot away just below the shoulder, the second lost both arms by the explosion of a shell, whilst he was in the act of lifting a pickaxe above his head, and the third lost his arm below the elbow. A man named Edward Sharpe has also been presented with a spinal apparatus, his vertebræ having been so severely injured by a spent ball as to prevent the poor fellow standing erect. By the aid of the spinal instrument employed, he now walks perfectly upright with the utmost ease. All these cases were of extreme severity; and without her Majesty's kindly aid had been exercised, the wounded men would have been unable to have procured the delicate mechanism they required. They are now capable of fulfilling any employment suitable to their condition.

The Express, *Thursday Evening*, *April* 3, 1856.

Her Majesty's Benevolence.—The Queen has commanded Mr. Heather Bigg, of 29, Leicester-square, the anatomical mechanician, to construct artificial legs for the following men, whose severe mutilation attracted her Majesty's notice during her recent visits to the hospitals of Portsmouth and Chatham, viz. :—Corporal Burland, John Connery, Francis Ready, Samuel Huson, Corporal Marks, and Patrick Kenny. With the exception of Kenny and Huson, who still retain each one leg, all these poor fellows had lost both legs. They are now, however, by her Majesty's bounty, enabled to walk as heretofore. In addition to these the Queen requested Mr. Bigg to supply — Greenway, William Boyce, and Henry Ashworth, with artificial arms. The first man had his arm shot away just below the shoulder, the second lost both arms by the explosion of a shell whilst he was in the act of lifting a pickaxe above his head, and the third lost his arm below the elbow. A man named Edward Sharpe has also been presented with a spinal apparatus, his vertebræ having been injured so severely by a spent ball as to prevent the poor fellow standing erect. By the aid of the spinal instrument employed, he now walks perfectly upright, with ease. All these cases were of extreme severity; and without the exercise of her Majesty's kindly aid, the wounded men would have been unable to procure the delicate mechanism they required. They are now competent to follow a variety of light occupations, for which otherwise they would have been disqualified.

BIRMINGHAM JOURNAL, *July*, 1856.

HER MAJESTY'S KINDNESS.

To the Editor of the *Birmingham Journal*.

Sir,—I have just received from Mr. Heather Bigg, No. 29, Leicester-square, London, an admirably finished artificial leg, executed by her Majesty's command, and feel assured that such repeated and gracious acts of kindness by her are equally well appreciated by your readers as by the recipients of her gifts. I therefore take the liberty of writing to you to this effect, and also enclose you a copy of my case, extracted from the *Times*, in May, 1855. To the kind intercession of the Rev. W. A. Hales, late of Birmingham, but now lecturer of St. Andrew's Church, Holborn, London, am I indebted in bringing my case again before her Majesty, and the obtaining of the artificial leg, and for whose kindness I shall ever feel grateful.

I remain, Sir, your obedient servant,
ROBERT EVANS,
Private, 13th Light Dragoons.

65, Warstone-lane, Hockley, Birmingham, 9th July, 1856.

(COPY.)

A BALAKLAVA DRAGOON AT FORT PITT.—Robert Evans, 13th Light Dragoons, a young man full of vigour, and with the best inclination to make use of his sabre in behalf of his country, was, in the ever-memorable charge of Balaklava, within six yards of the enemy's guns, when his horse received a shell in his chest, and from the rapidity with which he was advancing, completely turned heels over head, falling on Evans. While in this position, the shell burst in the chest of the horse, laying it open to the hind quarter. The young man laid lengthways under the horse, with his legs between those of the poor wounded animal's, at every convulsive struggle of which, Evans's legs were severely injured by the shoes of his horse, the youth's head, breast, and body being so completely under the animal as to prevent his calling for assistance. While the horse breathed, Evans took every opportunity of breathing also; but as life ebbed from the poor horse, the weight became greater, and Evans found the difficulty of fetching his breath increased. When the horse was dead, the weight was insufferable. In this position his groaning attracted the attention of two of the 17th Lancers and one of his own regiment, returning from the charge, who happily released him. The lengthened pressure rendered him quite frantic for several hours. He was taken by a doctor of the Rifles inside a battery, and had no use of his arms and legs for four days. His left ankle was injured, and with this and the lacerated state of both legs from the struggles of the horse, he was a month in the hospital at Scutari. Robert Evans entered Fort Pitt, January 20, 1855, where his youthful appearance and the severity of his case excited the sympathy of many influential persons, (the Earl of Darnley, Colonel Eden, Major Boys, Rev. Mr. Whiston, and others.) Upon the Queen's first visit Evans was in bed, but his case and the anticipated amputation of his leg was told her Majesty. When her Majesty was inspecting the wounded a second time, Evans was in the ranks with his crutches, holding his card. The Queen immediately asked if he was the youth whose leg was to have been amputated. She then feelingly enquired of him how he was, whether he felt much pain, and whether he was under chloroform? This youth, who has a married brother in the 13th Light Dragoons, is very well educated; he is still in Fort Pitt on his crutches, awaiting the complete healing of a wound from amputation, performed on the morning of March 28, 1855.—*Extract from the Times, May,* 1855.

BRISTOL TIMES, *Saturday, July* 12*th,* 1856.

THE QUEEN'S BENEVOLENCE.—We have recently had great pleasure in inspecting two beautifully contrived artificial legs presented by her Majesty the Queen to Corporal Burland, he being one of our brave Crimean soldiers, whose case excited her Majesty's gracious interest during the Royal visit to Chatham. These admirable substitutes for the natural limb were constructed at the express command of her Majesty by Mr. Heather Bigg, the well known anatomical mechanician, of 29, Leicester-square, London, and they are really masterpieces of skill and ingenuity.